Technical Report 564

Estimating The Manpower, Personnel, And Training Requirements Of The Army's Corps Support Weapon System Using The HARDMAN Methodology

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CSWS

ari

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> The HARDMAN methodology is designed to assess the human resource requirements of emerging weapons systems. The goal of this project was to examine the manpower, training and personnel demands of the Army's conceptual Corps Support Weapons System (CSWS), an indirect missile system capable of long-range interdiction missions. The project examined three alternative system configurations and compared them to a composite reference system. Steps 1 through 6 of the methodology were applied. The results of the project indicated that the multiple launch, tracked vehicle alternative was preferred from a manpower, personnel and training standpoint. Further information may be developed for the CSWS Special Task Force as required.

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FOREWORD

In 1977 the Chief of Naval Operations recognized the need for a systematic methodology for assessing manpower, personnel, and training requirements generated by emerging systems. Among the outcomes of the several actions which ensued was the establishment of a Hardware Procurement - Military Manpower (HARDMAN) Development Office. In 1978 the HARDMAN Development Office contracted with Dynamics Research Corporation for the design of a requirements determination methodology for applications of emerging Naval weapon systems. In 1980, application of the HARDMAN methodology was expanded to emerging Army systems under a contract from the Army Research Institute.

This report describes the application of the six steps of the HARDMAN methodology to a set of designs responsive to a Corps Support Weapon System (CSWS) concept. The methodology was used to conduct an analysis of the manpower, personnel, and training requirements and costs generated by the operation and maintenance of the CSWS projected major end items.

The HARDMAN methodology is an integrated set of data base management techniques and analytic tools, designed to provide timely, accurate, and fully documented assessments of the human resource requirements and cost associated with an emerging system's design. Additionally, the methodology provides the capability to determine the impact of a system's manpower, personnel, and training resource demand on a Service's current and/or projected supply of those assets, thereby targeting problem areas in system supportability. Effective tradeoff analyses can then be conducted through iteration of the methodology.

Volume I of this report details the application of the six steps of the HARDMAN methodology to CSWS and the project's findings. Volume II provides supporting or supplemental data in a number of appendices.

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BRIEF

Requirement:

During the acquisition of Army materiel systems as defined by the Life Cycle Systems Management Model (LCSMM), there is a continuing requirement for information on the personnel necessary to operate and maintain the equipment system, on the training requirements for the system, and on the costs associated with these human resource issues. Moreover, it is particularly important that these human resource demands be assessed early in the acquisition process, preferably before the major decision on hardware design occur (at Milestone I) since such decisions tend to implicitly define the human resource demand.

Procedure:

In response to these concerns, the HARDMAN (Hardware vs. Manpower) methodology was applied to the Army's Corps Support Weapon System (CSWS) concept. The CSWS is envisioned as an indirect fire system capable of interdicting and/or attriting targets at ranges as great as 200 kilometers beyond the forward line of friendly troops. The goal of the project was to determine human resource demands for three alternative system configurations and provide this information to the CSWS Special Task Force.

The methodology itself is composed of six major activities: Step 1, the development of a data base to support the analytic activities (Step 2-4); Step 2, the determination of the manpower requirements necessary to effectively operate and maintain the system; Step 3, the determination of the training resource requirements for the system; Step 4, the determination of the personnel requirements (e.g., recruiting requirements); Step 5, an integrated assessment of the cost and personnel impact of the proposed system; and Step 6, trade-off analyses (iteration of Step 1-5). The basic analytic approach is one in which data from similar existing systems and subsystems are modified and aggregated to form a description of the human resource demands of the proposed system.

The project applied Steps 1 through 6 of the methodology to three alternative CSWS systems, a single-launch alternative and two multiple launch alternatives. Each alternative consisted of a self-propelled launcher (SPL) and a missile resupply vehicle (RSV).

Findings:

The HARDMAN methodology was effective in providing the CSWS Special Task Force with estimates of manpower, personnel and training resource requirements. Moreover, the methodology helped to define the CSWS by requiring classification of numerous previously unspecified variables through its analytic processes and algorithms. The CSWS project demonstrates that each application of the methodology must be uniquely adapted to provide the analytic approach which documents and maintains the fluidity of the analysis despite the known risks and uncertainty of the program. However, in this regard it should be noted that several parts of the analysis still rely on expert judgment rather than explicit algorithms, and that while the approach has the face validity of its logic, it has not been empirically validated.

Utilization and Findings:

ARI will use the results of the project in its ongoing investigation of the general utility of the HARDMAN methodology in the Army's Weapon System Acquisition Process (WSAP). The specific estimates of human resource requirements for the various CSWS alternatives have been provided to the Special Task Force. It is anticipated that this information will be of great assistance now and in the future to the Special Task Force as it prepares for the various reviews required in the system acquisition process.

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SECTION 1 - EXECUTIVE SUMMARY

1.1 PURPOSE

In July, 1981, Dynamics Research Corporation (DRC) was placed under contract by the Fort Sill, Oklahoma, Field Unit of the U.S. Army Institute for the Behavioral and Social Sciences (ARI). The purpose of the contract was to apply the HARDMAN methodology to the Army's Corps Support Weapon System (CSWS). The HARDMAN methodology was developed by DRC for the U.S. Navy to determine the manpower, personnel, and training (MPT) requirements of emerging weapon systems. The HARDMAN methodology is an integrated set of data base management techniques and analytic tools designed to assess the human resource implications of design decisions. The methodology has already benefited the Navy by identifying adverse MPT impacts of conceptual weapon systems early enough in the acquisition process to allow corrective actions.

ARI sponsored the first Army HARDMAN application to determine if the benefits of the methodology were transferable to the Army. That effort concluded that the HARDMAN methodology was both feasible and useful for Army applications. However, this conclusion was limited since the methodology was only partially applied and only to a single end item from one weapon system. Before a definite conclusion as to the general utility of HARDMAN could be drawn, it was recognized that several full applications of HARDMAN across a variety of weapon systems would be necessary.

Concurrently, the CSWS Special Task Force (STF) was chartered by the Department of the Army to explore alternative system concepts for CSWS. The STF was established in 1981 at Fort Sill, Oklahoma. Based on the previous HARDMAN application to an Army system, the ARI Ft. Sill Field Unit determined that an application of HARDMAN could establish the human resource implications of the CSWS alternative system concepts and hence facilitate early decisions affecting the CSWS.

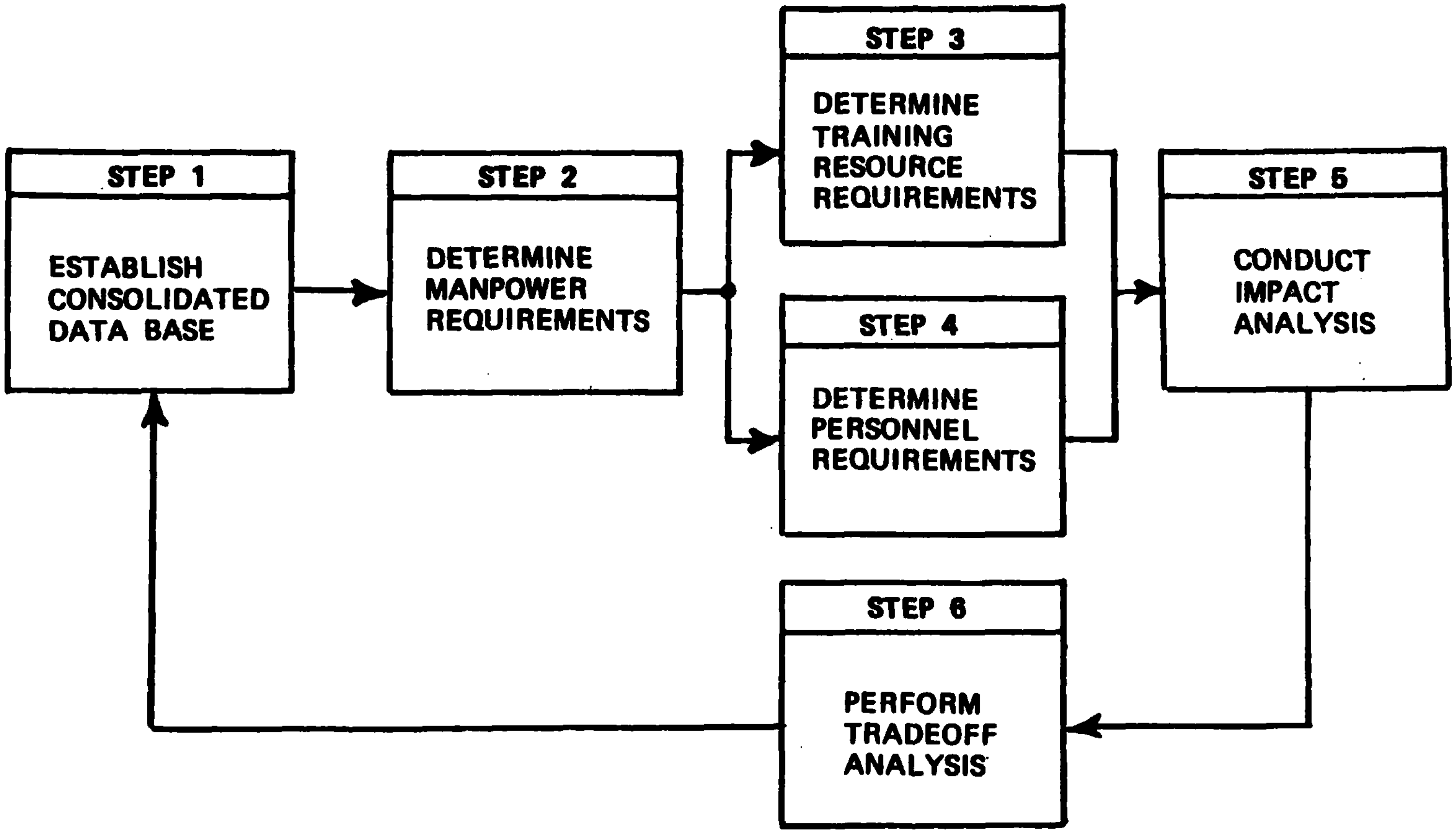
Thus, the application of HARDMAN to CSWS which is the subject of this report has two mutually supporting goals:

- To support early decision-making on alternative CSWS system concepts by the CSWS Special Task Force.
- To increase the body of evidence supporting the general utility of the HARDMAN methodology for Army systems.

1.2 SCOPE OF THE PROJECT

The Corps Support Weapon System (CSWS) is envisioned as an indirect fire system capable of interdicting and/or attriting targets at ranges as great as 200 kilometers beyond the forward line of friendly troops. CSWS will be designed to be a highly mobile, all weather, rapid fire, guided missile system designed to provide a U.S. Corps commander with a much larger area of influence than presently available. CSWS must effectively integrate existing and developmental target acquisition, communications, command and control, and ordnance delivery systems. It must be capable of delivering conventional, chemical and nuclear munitions.

Figure 1-1. STEPS IN THE METHODOLOGY.



CSWS is in a very preliminary stage in the Weapon System Acquisition Process (WSAP). The Mission Element Need Statement, which normally initiates program development, was issued during April, 1981; however, the WSAP has not proceeded as originally scheduled. As of the date of this report, there is no firm date set for the Milestone I review by the Army Systems Acquisition Review Council (ASARC). Therefore, the potential baseline solutions for CSWS were initially (and to some extent, still are) theoretically unlimited. As a result, the DRC Program Manager and the CSWS Special Task Force (STF) met and defined the system concepts to be examined during the study. The scope of the study was limited to the following:

(1) All six steps of the HARDMAN methodology;

(2) Self-Propelled Launcher (SPL), Resupply Vehicle (RSV), and missile;

(3) Direct (i.e., non-supervisory) manpower requirements for operators and maintainers for these vehicles;

(4) Crew, organizational, and direct support levels of maintenance; and

(5) Requirements to be determined for two reference systems and three baseline alternatives. (Definitions of these terms are provided in Section 2.2, of the report.)

The system concept for the three baselines were:

- A single launch alternative based on an improved LANCE missile system.
- A multiple launch alternative based on the Multiple Launch Rocket System (MLRS).
- A multiple launch alternative based on a LANCE II missile mounted on a heavy wheeled carrier.

More complete descriptions of both the CSWS system concept and the various alternatives are contained in Section 3.

1.3 DESCRIPTION OF THE HARDMAN METHODOLOGY

The HARDMAN methodology is composed of six major interrelated steps (Figure 1-1). All six steps of the methodology were performed as part of the CSWS effort. A brief description of each step follows:

Step 1 - Establish a Consolidated Data Base (CDB)

During Step 1 two major functions are accomplished. First, the reference and baseline systems are developed and the design differences between them are evaluated. Second, all data required to support this and subsequent HARDMAN analyses are identified, collected, and formatted.

Step 2 - Determine Manpower Requirements

In the Manpower Requirements Analysis the manpower requirement of the baseline system is estimated. Where appropriate, this requirement can include civil service and contractor as well as military manpower, through all echelons of maintenance. This estimate is derived from workload generated by operational and maintenance task/event networks using the reference system as a point of departure. Changes in manpower requirements are functions of the design differences identified in Step 1.

Step 3 - Determine Training Resource Requirements

During the Training Resource Requirements Analysis, training data collected for the reference system are modified to reflect the design differences in the baseline design. Thus, changes are made in the tasks to be performed (e.g., task time, frequency, content), in individual courses (to account for the general task changes), and in course resources and cost. The impacts of these changes are aggregated to determine estimates of training, training resources, and cost for the baseline system.

Step 4 - Determine Personnel Requirements

The Personnel Requirements Analysis determines the total personnel demand of the reference and baseline systems. This total requirement consists of (a) personnel required "on board" to operate and maintain the system, plus (b) the pipeline personnel who must be "grown" in the system to consistently meet the manpower requirements determined in Step 2. The Interactive Manpower-Personnel Assessment and Correlation Technology (IMPACT) model is used to determine the total personnel requirements of the baseline system.

Step 5 - Conduct Impact Analysis

The Impact Analysis determines the Army's supply of those manpower and training resources required by the baseline system and measures that supply projection against the MPT demand (determined in Steps 2 through 4). It identifies (a) new requirements for skills, training, and training resources; (b) design and other sources of high human resource demand; (c) requirements for scarce assets such as skills and training resources; and (d) high cost components of the manpower, personnel, and training requirements associated with the baseline system. These products include many of the data elements required in current Department of Defense/-Department of the Army documentation for program reviews.

Step 6 - Perform Tradeoff Analysis

The Tradeoff Analysis prioritizes the critical requirements (established in Step 5) according to their impact on resource availability. A range of potential solutions to each requirement is determined and prioritized for analysis. The HARDMAN methodology is then iterated to develop the most effective response to each critical resource requirement. Both the data for and the findings of these analyses are included in the CDB, thereby insuring that a complete audit trail is generated.

1.4 RESULTS

Table 1-1 illustrates the results of this effort with respect to the two reference and three baseline systems analyzed for CSWS. The Multiple Launch Interdiction System (MLIS) alternative emerges as the preferred candidate, as the boxed figures highlight. Some of the more specific results are contained in the following paragraphs, and are discussed in more detail in the appropriate sections of this report.

Mission

- The MLIS Self-Propelled Launcher (SPL) is able to complete its assigned missions in 50% and l6% less time than the ILANCE AND LANCE II alternatives, respectively. That is, the MLIS could theoretically support twice the mission load of the ILANCE in the same time period.

TABLE 1-1. CSWS RESULTS SUMMARY

CATEGORY	Reference Systems: Tracked	Reference Systems: Wheeled	Baseline Systems: I Lance	Baseline Systems: MLIS	Baseline Systems: Lance II
MISSION					
STANDBY TIME %					
SPL	17.6	52.6	15.5	57.7	49.8
RSV	42.4	69.0	40.6	69.1	55.2
MANPOWER					
CREW	1260	1080	1260	1080	1080
ORGANIZATIONAL MAINTENANCE	570	380	390	290	360
DS MAINTENANCE	825	635	590	380	465
PERSONNEL					
NUMBER OF MOS	16	14	16	16	14
PERSONNEL REQUIREMENTS	7137	5945	5872	5040	5203
ANNUAL RECRUIT RATE	1668.1	1404.3	1343.8	1178.9	1183.8
TRAINING					
ANNUAL TRAINING MAN-DAYS (K)	174.7	141.2	134.7	101.3	111.5
ANNUAL INSTRUCTOR REQUIREMENTS	162.6	132.7	128.9	91.6	105.6
ANNUAL COURSE COSTS ($M)	$31.980	$25.225	$23.580	$18.108	$19.709

Manpower

- The SPLs for all alternatives required a crew of 3. The resupply vehicles on the multiple launch alternatives required 1 less crew member than the single launch alternatives (3 vs 4). This situation was due to shorter and less frequent resupply times on the multiple launch alternatives.
- Organizational maintenance manpower requirements varied from a low of 29 positions per battalion (MLIS) to a high of 39 positions per battalion (ILANCE) for the baseline systems (290 vs 390 for 10 battalions)
- Direct support (DS) maintenance manpower requirements varied from a low of 76 positions per DS unit (MLIS) to a high of 118 positions per DS unit (ILANCE) for the baseline systems (380 vs 590 for 5 DS units).
- Differences in manpower appear to result more from the combination of launch capacity and scenario assumptions than to large differences in system reliability and maintainability.

Personnel

- The wheeled systems required fewer Military Occupational Specialties (MOS) than the tracked systems (14 vs 16).
- Personnel requirements, i.e, the number of people required in the structure to support the above manpower requirements, varied from a low of 5040 (MLIS) to a high of 5872 (ILANCE) for the baseline systems.
- All of the baseline systems required fewer personnel than either of the reference systems.

Training

- 2 new skills are required for CSWS. These are 15XX CSWS Crewmember, and ASIXX, CSWS Organizational Mechanic.
- The training for 6 existing maintenance MOS must be modified to accommodate training for the CSWS system. These are

  27B Land Combat Support Test Specialist/LANCE Repairer
  31E Field Radio Repairer
  31V Tactical Communications System Operator/Mechanic
  35E Special Electronic Devices Repairer
  63H Tracked Vehicle Repairer
  63W Wheeled Vehicle Repairer

- A total of 16 new or modified courses were developed for the new and modified MOS. This number was necessary to reflect design differences across the three CSWS baseline configurations.
- CSWS can use 9 existing MOS without modification to their respective training program.
- The requirements for annual training man-days varied from a low of 101,271 (MLIS) to a high of 134,658 (ILANCE) for the baseline systems.
- Instructor requirements varied from a low of 91.6 (MLIS) to a high of 128.9 (ILANCE) for the baseline systems.
- Annual training course costs varied from a low of $18.1 million (MLIS) to a high of $23.6 million (ILANCE) for the baseline systems.

- All of the baseline systems were less intensive in their use of training resources than either of the reference systems, with MLIS being the least intensive.

Impact

- All of the alternatives will have negative impacts upon presently available personnel and training resources, since CSWS is assumed to be additive to the Army's force structure.
- CSWS impacts on available personnel result in only two significant shortfalls (i.e., demand in excess of supply). These are for MOS 15XX, CSWS crewmembers, in which supply is likely to satisfy an average 74% of demand, and 27B, Land Combat Support Test Specialist/LANCE Repairers, in which supply satisfies an average 85% of demand.

1.5 FACTORS INFLUENCING RESULTS

The character of this analysis was influenced by a number of underlying assumptions and/or constraints. A brief summary of each is listed below.

System Design

- Each selected reference system meets all or nearly all projected CSWS operational requirements specified in the Battlefield Development Plan and other program documentation.
- Equipment assemblies not specifically mentioned in the baseline designs but necessary to allow other systems to function, were assumed to be present. Since the omitted equipment assemblies were not specifically mentioned, it was further assumed that no new technologies in these areas were projected for the three baselines.
- Reference system Reliability, Availability, Maintainability (RAM) data were used in areas where actual, projected or Development Test/Operational Test (DT/OT) baseline data were lacking. These reference system data were perturbed to reflect the projected impact from emerging technologies. In most instances, these projections were based on Army source documents.

Force Structure

- CSWS will represent a complete addition to the Army's force structure, i.e. CSWS will not replace an existing system.
- End strength is constrained at current and/or projected levels. That is, the increase in requirements represented by CSWS must be accomodated within present resources, without specification as to the exact source of those resources.
- Aggregate CSWS MPT requirements are based on a total requirement for the 180 Self-Propelled Launchers (SPL) and 180 Resupply Vehicles (RSV).

System Operation

- Mission profile/operational mode information represents the "best estimates" of DRC personnel from all available sources, including the CSWS Special Task Force. The official Mission Profile/Operational Mode Summary was not available for this analysis.

Manpower

- Allowances and constraints for estimating manpower from the Army Manpower Authorization Criteria (MACRIT) process, contained in Army Regulation 570-2, were incorporated into the analysis.
- The capacity factor of the basic MACRIT equation was modified to provide a more realistic availability factor for individuals operating within the specified mission environment.
- A seven day standard workweek was developed using the above information. Workload requirements were based on this standard workweek.

Personnel

- The DRC-developed Interactive Manpower-Personnel Assessment and Correlation Technology (IMPACT) model, which computes system-specific personnel requirements, is driven by steady-state manpower requirements. As a result, it is assumed that manpower requirements are already filled, and therefore, the personnel requirements represent the quantities of personnel which it takes to *sustain* these already-filled manpower requirements.
- The IMPACT model uses historical personnel flow rates, which are extracted and calculated from the Enlisted Master File (EMF), via the Defense Manpower Data Center (DMDC). It is assumed that these input rates, or personnel flow rates, are accurate for their intended purpose.

Training

- All estimates in the Training Resource Requirements Analysis (TRRA) are based on the best available data, and projections are made from the existing subsystem, courses, and so on, which most closely meet the functional requirements of the proposed system.
- Training resources and costs are estimated for the "steady-state" or average value year where the "steady-state year" is defined as the first year in which the Army training system is producing replacement training only (that is, all systems have been deployed and training is focused on filling billets vacated through attrition and promotion).
- Training associated with the operational test and evaluation of the proposed system and training associated with the initial fielding of the system (e.g., new equipment training) are not estimated.
- Only the resources and costs associated with entry level institutional training are estimated in the present version of the TRRA. Training resources and costs associated with unit training, advanced technical or Non-Commissioned Officer Education System (NCOES) training, warrant officer, and officer training are not estimated.
- Acquisition costs associated with the development of training products are not estimated.
- All established training is assumed to be adequately meeting existing system performance requirements in this iteration of the methodology.

1.6 CONCLUSIONS AND RECOMMENDATIONS

The MLIS alternative emerges as the preferred candidate for CSWS from a manpower personnel and training(MPT) standpoint, due to its low demand for these resources. This preference appears to be the result of a combination of several factors for MLIS: ease of resupply, multiple launch capabilities, and scenario assumptions. Since the latter are not authoritative, the preference for MLIS over LANCE II may be reduced or eliminated under mission profiles/operational modes different from those used in this study. This issue should be the subject of additional tradeoff analysis subsequent to this report. Other tradeoffs are also recommended, particularly one including a multiple round resupply capability for the LANCE II alternative. The absence of such a capability also was a factor in the preference for MLIS over LANCE II.

As this report illustrates, the HARDMAN methodology can provide a wealth of timely information to those concerned with systems development and acquisition. This situation is true despite problems encountered in obtaining the basic data required for the various HARDMAN analyses. Nevertheless, the CSWS application of HARDMAN again demonstrates the versatility and utility of the methodology in support of the Weapon Systems Acquisition Process.

SECTION 2 - THE HARDMAN METHODOLOGY

2.1 APPLICATION DURING THE WEAPON SYSTEM ACQUISITION PROCESS (WSAP)

The HARDMAN methodology is designed primarily for front-end analysis; it determines human resource requirements, identifies high resource drivers, and provides the necessary information to conduct human resource/equipment design tradeoffs during the early phases of the WSAP. Studies have shown that at the time of the initiation of full scale engineering development at DSARC II, as much as 80 percent of a weapon system's design has been fixed. Thus, MPT analysis can effectively influence design only during the concept exploration and validation phases of weapon system development. After design "lock-in," supportability and affordability assessments occur too late to support productive tradeoff analyses. Moreover, performing front-end analysis of MPT requirements even earlier in the development/acquisition process, during Mission Area Analysis (MAA), contributes to the selection of an appropriate (i.e., supportable as well as mission capable) response to an identified mission need. Therefore, front-end analysis, as it pertains to the HARDMAN methodology, can be defined as:

> A process that evaluates requirements for manpower, personnel, and training (MPT) during the early stages of the military systems acquisition cycle. Its purpose is to (a) determine MPT requirements under alternative system concepts and designs, and (b) estimate the impact of these MPT requirements on system effectiveness and life cycle costs. Its end-product should be the information needed to insure that effective resources (human, equipment, material) will be available when and as required for each system to achieve its intended contribution to military readiness and effectiveness.[1]

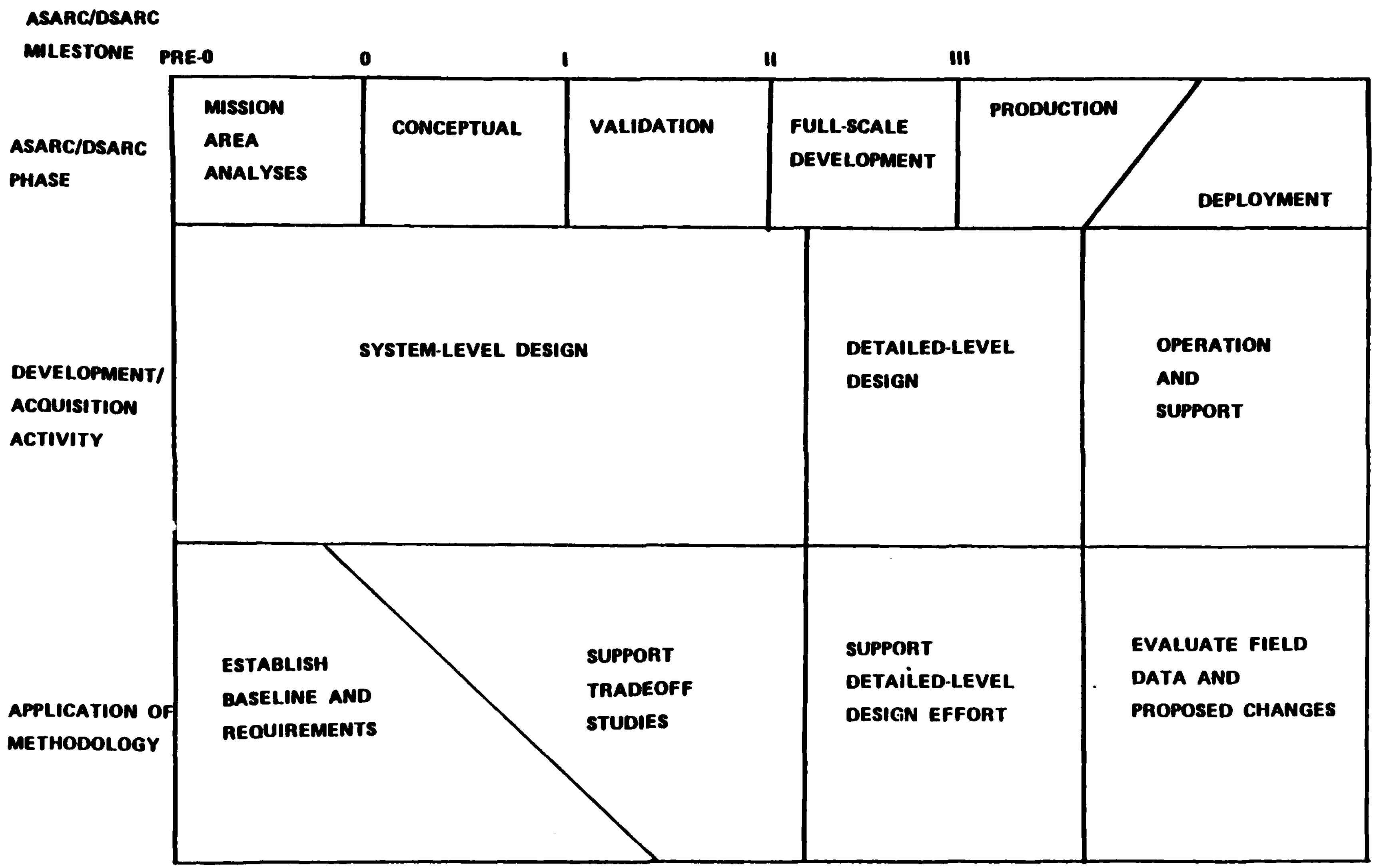
In addition to front-end analysis, the methodology is designed to serve useful functions later in the acquisition process (see Figure 2-1). During the full-scale development phase, it can be used to contribute to detailed-level logistics support analyses (LSA) and the development of such documents as the Logistics Support Analysis Record (LSAR), the Quantitative and Qualitative Personnel Requirements Information (QQPRI), the Basis of Issue Plan (BOIP), the Outline Individual and Collective Training Plan (OICTP), and the New Equipment Training Plan (NETP). After production and deployment, the methodology can be used to analyze the impact, in terms of MPT requirements, of proposed modifications to a weapon system.

2.2 AN ACQUISITION MANAGEMENT TOOL

The HARDMAN methodology provides techniques for (a) resource requirements determination, (b) resource availability assessment, (c) impact analysis, and (d) tradeoff analyses. The resource requirements analyses project the numbered dollar cost of manpower, personnel and training resources for a baseline weapon system. These findings approximate the human resource demand of the conceptual system.

[1] *Front-End Analysis to Aid Emerging Training Systems*, Workshop Summary, HUMRRO SR-ETSD-80-3, February 1980.

Figure 2-1. USE OF THE METHODOLOGY.



Resource availability assessment identifies the supply of personnel and training resources that can be expected at critical dates in the conceptual system's acquisition schedule. Personnel availability analysis projects the future supply of operators, maintainers, and support personnel given current supply and expected accession and retention rates, career progression, and duty rotation rates for each Military Occupational Specialty (MOS) of interest. Training availability analysis performs the same function for critical training resource elements, such as instructors. While both of these analytic tools are in a rudimentary state, the flexible format of the methodology allows incorporation of state-of-the-art supply projection methodologies as they become available.

The impact analysis matches demand to supply and identifies shortfalls in skills, new skill requirements, and high resource drivers. The tradeoff analysis then determines alternatives to lessen or shift these impacts and examines their benefits in relation to their costs. This evaluation is performed by iterating the methodology.

The methodology utilizes two important analytic techniques to accomplish its objectives. First, comparability analysis is employed to derive systematic estimates of the human resource requirements of conceptual (also called baseline) systems during the earliest phases of their development. Determination of the requirements for these baseline systems occurs in a two-step process. In the first step, a reference system is constructed and reference data are collected. The reference system consists of comparable components/equipments from existing systems in DoD/NATO inventory, configured to satisfy the functional requirements (operation and support) specified for the projected system. In the second step, reference data are modified to reflect the impact of design differences between the reference system and a second, equally capable, baseline system. This baseline system incorporates low risk technological advances likely to be extant prior to the Initial Operational Capability (IOC) date for the conceptual weapons system. Estimated requirements are thus a function of relatively mature data and carefully controlled comparisons between fielded and emerging technologies.

The methodology's second key analytic tool is a Consolidated Data Base (CDB) employing advanced data base management techniques. The CDB includes all of the data necessary to apply the HARDMAN methodology; this information characterizes the equipment, maintenance concept, operator and supervisor tasks, and resultant human resource requirements associated with all systems and subsystems. Consequently, all members of the program management office and the design community use identical data definitions and formats. Human factors engineers, training developers, design engineers, and manpower planners have access to and employ the same data in their individual analyses. Further, the CDB also contains a detailed audit trail which describes all internal documentation (such as worksheets, computer printouts, and programming sheets) used in the application of the methodology.

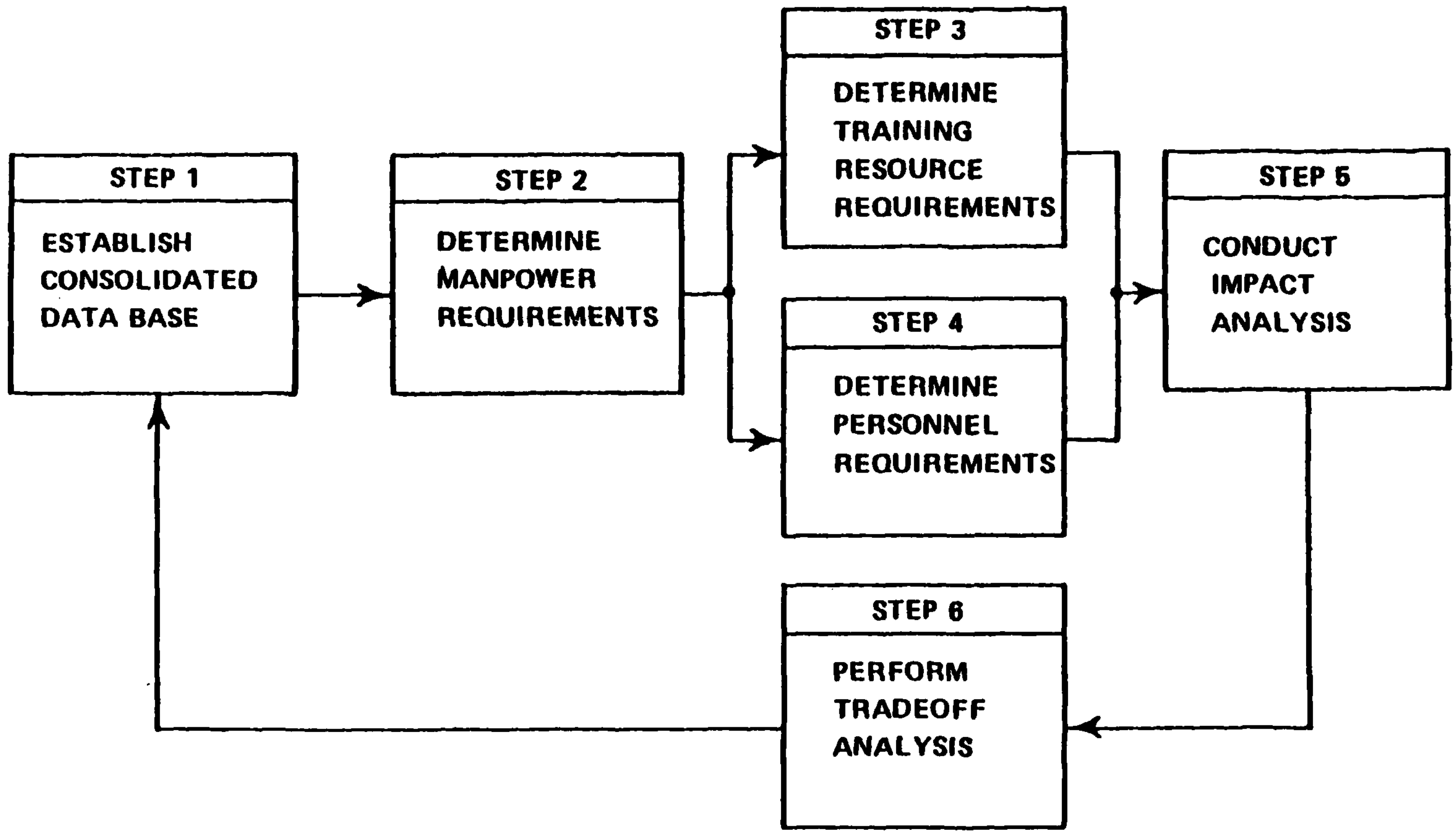
2.3 MAJOR STEPS IN THE HARDMAN METHODOLOGY

The HARDMAN methodology is composed of six major interrelated steps (see Figure 2-2). A general description of each step follows:

Step 1 - Establish a Consolidated Data Base (CDB)

During Step 1, two major functions are accomplished. First, the reference and baseline systems are developed and the design differences are evaluated in terms of their projected impact on the reference system's operational and/or support characteristics. Second, all data required to support this and subsequent HARDMAN analyses are identified, collected, and formatted. These data include operational and support specifications for the baseline weapon system; systems engineering data, and manpower, personnel, training, training resource, and cost data

Figure 2-2 STEPS IN METHODOLOGY



Step 2 - Determine Manpower Requirements

In the Manpower Requirements Analysis, systematic descriptions of the general operator and maintainer tasks/events are developed for the reference system. (Task/events describe functional activity at a more general level then the "tasks" typically used by training analysts.) Included in these task/event networks are empirically based estimates of the time, support equipment, and number and skill level of personnel required to perform each task/event. Given a mission scenario, the reference system task/event networks can be used to derive the workload for preventive, scheduled and unscheduled maintenance, operational manning, and indirect or own unit support. Further, the reference system task/event descriptions can be modified to reflect the impact of the design differences and then used to determine workload estimates for the baseline system. These findings can then be used with the Army Manpower Authorization Criteria (MACRIT) process and/or a similar manpower determination model to estimate the number of productive personnel (operators and maintainers) and support and administrative personnel required to "man" the system. Additionally, the reliability and maintainability analysis, used in the maintenance task/event networks, will provide a range of metrics for identifying subsystem sources of high resource demand and for comparing performance among systems.

Step 3 - Determine Training Resource Requirements

During the Training Resource Requirements Analysis, training data are collected for the reference system. These data are then modified to reflect the design differences in the baseline design. Thus, changes are made in the operational and maintenance tasks to be performed, in individual courses (to account for the general task changes), and in course resources and cost. The impacts of these changes are aggregated to determine estimates of training, training resources, and cost for the conceptual system. Additionally, a representation of the training paths for reference system personnel is developed and then modified to account for the changes in training required by the proposed baseline system(s). Consequently, the impact of conceptual changes in training on the Army's personnel and training systems can be assessed.

Step 4 - Determine Personnel Requirements

The purpose of the Personnel Requirements Analysis is to determine the total personnel demand of the reference and baseline systems. This total requirement consists of (a) personnel required "on-board" to operate and maintain the system, plus (b) the pipeline personnel who must be "grown" in the system to consistently meet the unit manpower requirements. This latter category of personnel is determined by constructing career paths which describe training paths, attrition rates and advancement probabilities, for the MOS's required by the reference system. These reference system career paths are then modified to reflect changes in baseline system manning (determined in Step 2) and training (determined in Step 3). The Interactive Manpower-Personnel Assessment and Correlation Technology (IMPACT) model is applied to these parameters to determine the total personnel requirements of the conceptual system.

Step 5 - Conduct Impact Analysis

The Impact Analysis determines the Army's supply of those personnel and training resources required by the baseline system and measures that supply projection against the MPT demand (determined in Steps 2 through 4). It identifies (a) new requirements for skills, training, and training resources; (b) design and other sources of high human resource demand; (c) requirements for scarce assets such as skills and training resources; and (d) high cost components of the manpower, personnel, and training requirements associated with the baseline system. These products include many of the data elements required in current Department of Defense/Department of the Army documentation for program reviews. These products will also assist the program manager in targeting areas for human resource/equipment design tradeoff studies.

Step 6 - Perform Tradeoff Analysis

The Tradeoff Analysis prioritizes the critical requirements (established in Step 5) according to their impact on resource availability. A range of potential solutions to each requirement is then determined and each is prioritized for more detailed analysis. The HARDMAN methodology is then iterated to develop the most effective response to each critical resource requirement. Both the data for and the findings of these analyses are included in the CDB, thereby insuring that a complete audit trail is generated and that the most up-to-date data are available to all members of the program staff.

2.4 BENEFITS OF USING THE HARDMAN METHODOLOGY

Systematic application of the HARDMAN methodology to an emerging weapon system will provide the following benefits:

- Early Estimates of MPT Requirements.

  The HARDMAN methodology determines the demand of a weapon system design in terms of manpower, personnel, and training. It provides these assessments during the early phases of the weapon system acquisition process, when they can have the greatest impact on the system's emerging design.

- Visibility to High Resource Drivers.

  System design characteristics, operational/support concepts and/or service policies which generate a significant demand for MPT resources are identified. This information is critical if the impacts of these requirements are to be decreased or their growth effectively managed during design maturation.

- Tradeoff Analysis Capability.

  The HARDMAN methodology is designed to conduct human resource/equipment design tradeoffs during the early phases of the WSAP. Hence, support ability considerations can be incorporated in any analysis of a system's capability and afford ability.

- Fully-Documented Audit Trail.

  A comprehensive record of all analyses and their findings is developed during each application of the methodology. Consequently, each estimate of MPT requirements associated with a system design can be systematically updated and/or verified.

- Provides Data Elements for Required Program Reports.

  The HARDMAN methodology develops many of the data elements required in program reports, as specified by Department of Defense Directive 5000.1, Department of Defense Instruction 5000.2, and Department of Defense Directive 5000.39.

- Support of Detailed Level Analysis Later in the WSAP.

  The data base and resource estimates, developed by the HARDMAN methodology during the early phases of the acquisition process, provide a solid foundation for more of the rigorous analyses conducted in the later phases (e.g., logistics support analysis, instructional systems development). Thus, estimates of MPT resource requirements are systematically updated and refined in a coherent and coordinated analysis process.

- Integration of Advanced Analysis Techniques and Current/Approved Army Analytic Tools.

The HARDMAN methodology uses a flexible format capable of effectively joining the data requirements and products both of state-of-the-art analytic processes (e.g., average value modeling, regression analysis) and of approved Army models. Consequently, all findings can be clearly related to Army standards, procedures, and practices.

SECTION 3 - ESTABLISH THE CONSOLIDATED DATA BASE

3.1 BACKGROUND

The HARDMAN methodology provides great flexibility in its application and must be tailored to the requirements of each study. The application of HARDMAN to the Corps Support Weapon System (CSWS) was similar in many respects to the initial application of HARDMAN to an Army system, the Division Support Weapon System (DSWS). This situation was not surprising since both are field artillery systems and designed for similar, if not identical tasks, on the battlefield, i.e., the fire support mission. In this and subsequent sections of this report, details of the application of HARDMAN to CSWS, which are essentially the same as in the DSWS application, are omitted. Those aspects of the CSWS application which differ significantly from DSWS are reported in more detail.

3.2 COLLECT AND REVIEW INITIAL INFORMATION

The CSWS study represents the earliest point that the HARDMAN methodology has been applied in the weapons system acquisition process (WSAP). Hence, there was less program documentation than is normally available later in the acquisition cycle. Only three documents providing initial program information were available to define the scope of CSWS. These documents were the Battlefield Development Plan (BDP), published by the U.S. Army Training and Doctrine Command (TRADOC); the Phase I and Phase II Fire Support Mission Area Analyses from the U.S. Army Field Artillery Center and School; and the initial Corps Support Weapon System Operational and Organizational (O&O) Plan. The system definition documents, specifically the Mission Element Need Statement (MENS), were not available for this effort; however, the threat definition and system capabilities that are a part of the MENS were obtained from the O&O Plan and referred to in both contractor proposals.

Examination of the available sources provided insufficient detail relative to the various conceptual CSWS configurations that could be examined; as a result the DRC Program Manager and the CSWS Special Task Force (STF) Director met and defined the system concepts to be examined during the analysis. The scope was limited to the following:

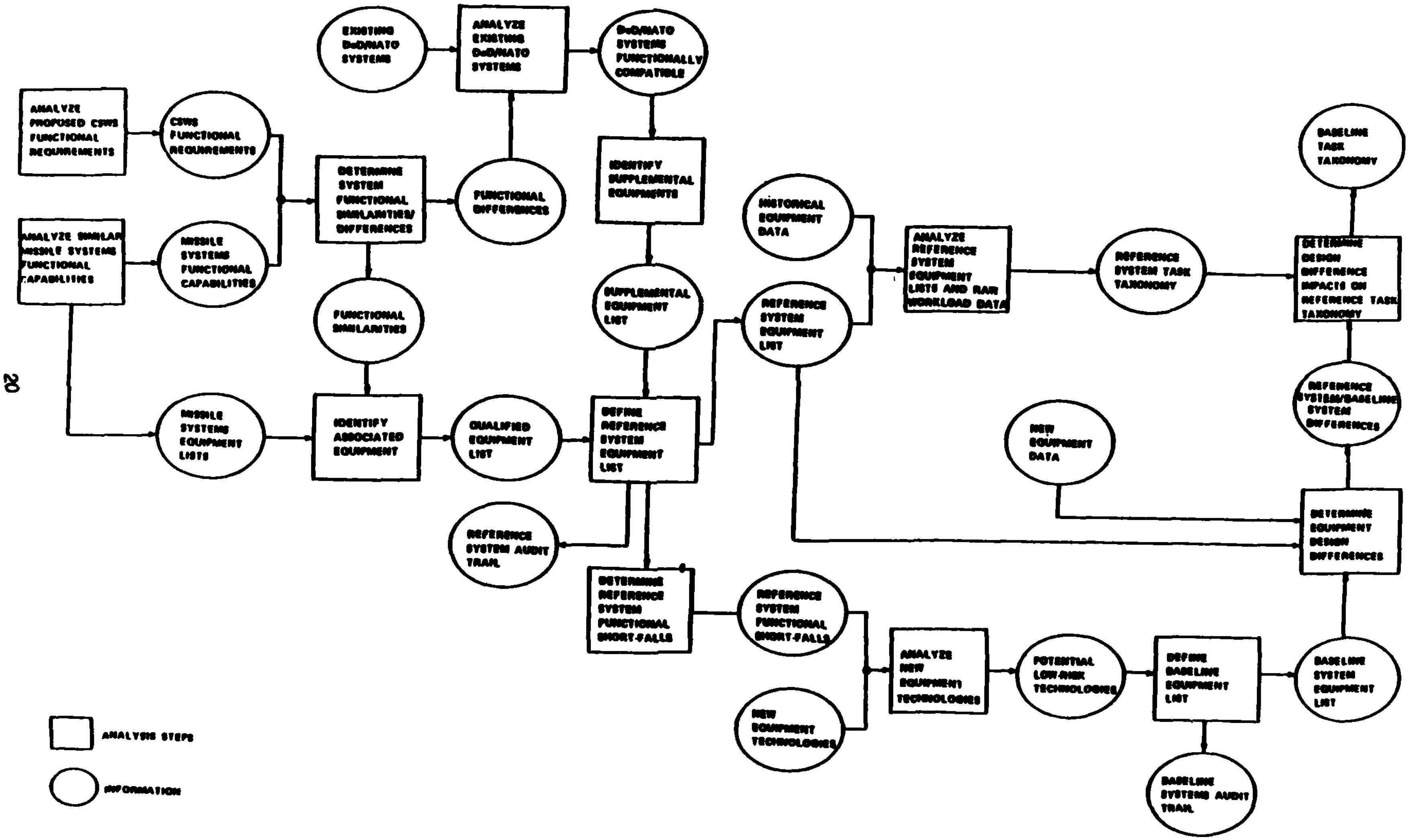
(1) Self-Propelled Launcher (SPL), Resupply Vehicle (RSV), and missile;

(2) Direct (i.e., non-supervisory) manpower requirements for operators and maintainers for these systems;

(3) Crew, organizational, and direct support levels of maintenance;

(4) Requirements to be determined for two reference systems and three baseline alternatives.

Figure 3-1. Perform System Analysis.



The system concepts for the three baselines were:

- a single launch alternative based on an improved LANCE missile system (ILANCE).
- a multiple launch alternative, the Multiple Launch Interdiction System (MLIS) based on the Multiple Launch Rocket System (MLRS).
- a multiple launch alternative based on a LANCE II missile mounted on a heavy wheeled carrier (LANCE II).

Once the scope was defined, work began on collecting generalized reference information files. These files represent the compilation of documents, papers, and other pertinent information used in the HARDMAN process and henceforth referred to as the Consolidated Data Base (CDB). The CDB includes the relevant background information known or considered to be of value to the analyses and suitably arranged for ready identification and location of material.

3.3 PERFORM SYSTEMS ANALYSIS

Systems analysis in the HARDMAN methodology essentially consists of two processes:

- Functional requirements analysis identifies the full range of functions that the system should perform.
- Engineering analysis defines what specific equipment/components will be employed by the system to perform these functions.

As a general technique, both processes move from the generic to the specific; i.e., generic system functional requirements are delineated first and, through subsequent iterations, become progressively more detailed. At some level of detail of system functional requirements, it is possible to construct both a generic equipment list and a generic task taxonomy for the new system. The former is used in engineering analysis to construct the reference and baseline systems; the latter is used similarly in manpower analysis to determine reference and baseline tasks.

Figure 3-1 depicts the detailed sequence of the procedures used in performing systems analysis. While distinctly delineated in theory, in practice, the analyses are interdependent and the lines of demarcation between them tend to be easily blurred. Thus, the remainder of this section describes the sequence only at the general level of the two major analytic processes, the functional requirements and engineering analyses.

3.3.1 System Functional Requirements Analysis

The CSWS functional requirements were defined in three steps.

- The mission requirements were defined and synthesized for a generic guided missile system.
- The system requirements of CSWS were identified and converted into a generic equipment configuration.

- The system functions and equipment were used to develop the structure of the system task taxonomy.

The generic task taxonomy is not included in this section because it was used to develop specific manpower tasks which are described in the manpower analysis section of this report.

Identify CSWS Mission Requirements

CSWS mission requirements were defined in response to the description of the enemy threat. The primary source used to determine this threat was the DARCOM publication *Threat Description, Threat Organization Tactics and Equipment*. The major characteristics of this threat are (a) U.S. forces will be outnumbered, (b) Enemy tactics will employ deep second echelons for reinforcing front line units, (c) Enemy forces will be highly mobile, (d) Enemy forces have NBC weapons available for use in a sustained conflict, (5) Enemy forces will employ electronic warfare.

The TRADOC Battlefield Development Plan (BDP) was prepared as a tactical plan to defeat this threat in the next air/land battle. The BDP identified a new battlefield task, "Interdiction of the Second Echelon." The purpose of this new task is to overcome and prevent enemy force generation, e.g., reinforcement of the enemy first echelon.

The development of the BDP was followed by the *Fire Support Mission Area Analysis (MAA) Phase I* and the *Fire Support Mission Area Analysis (MAA) Phase II*. The identification of the interdiction task resulted in the need for a multi-service weapon system which was initially called "Assault Breaker." This system included an intelligence element, a communication and target cell element, and individual weapon systems. The Corps Support Weapon System is the Army's proposed weapon system for performing this interdiction mission.

CSWS will perform this new mission while assigned in a general support or general support reinforcing role. The Phase II MAA explicitly states that existing "missile systems lack a deep conventional capability" for performing the interdiction task. Indeed, no U.S. system presently fielded has this particular capability; thus, in operational terms, CSWS has no comparable predecessor system.

System Requirements

In this phase of the analysis, the generic functions/ subfunctions performed by a missile system in accomplishing its mission were identified and documented. Five data elements related to the function were also identified.

(1) Measure - The units of measurement, e.g., time, accuracy.

(2) Improvement - The change in the measure, e.g., increase, reduce.

(3) Performance Standard - The degree or objective of the change in the measure.

(4) Outcome - The desired result of the change.

(5) Threat Condition - The threat characteristic which makes the change desirable.

The LANCE missile system was used to identify generic missile functions.

Analysis Results

The full documentation of CSWS Functional Requirements is contained in Appendix A1. Figure 3-2 summarizes the results of the functional requirements analysis. It depicts the relationship between the mission requirements, system functions, system performance measures, generic subsystems, and CSWS end items.

Figure 3-2. FUNCTIONAL REQUIREMENTS ANALYSIS.

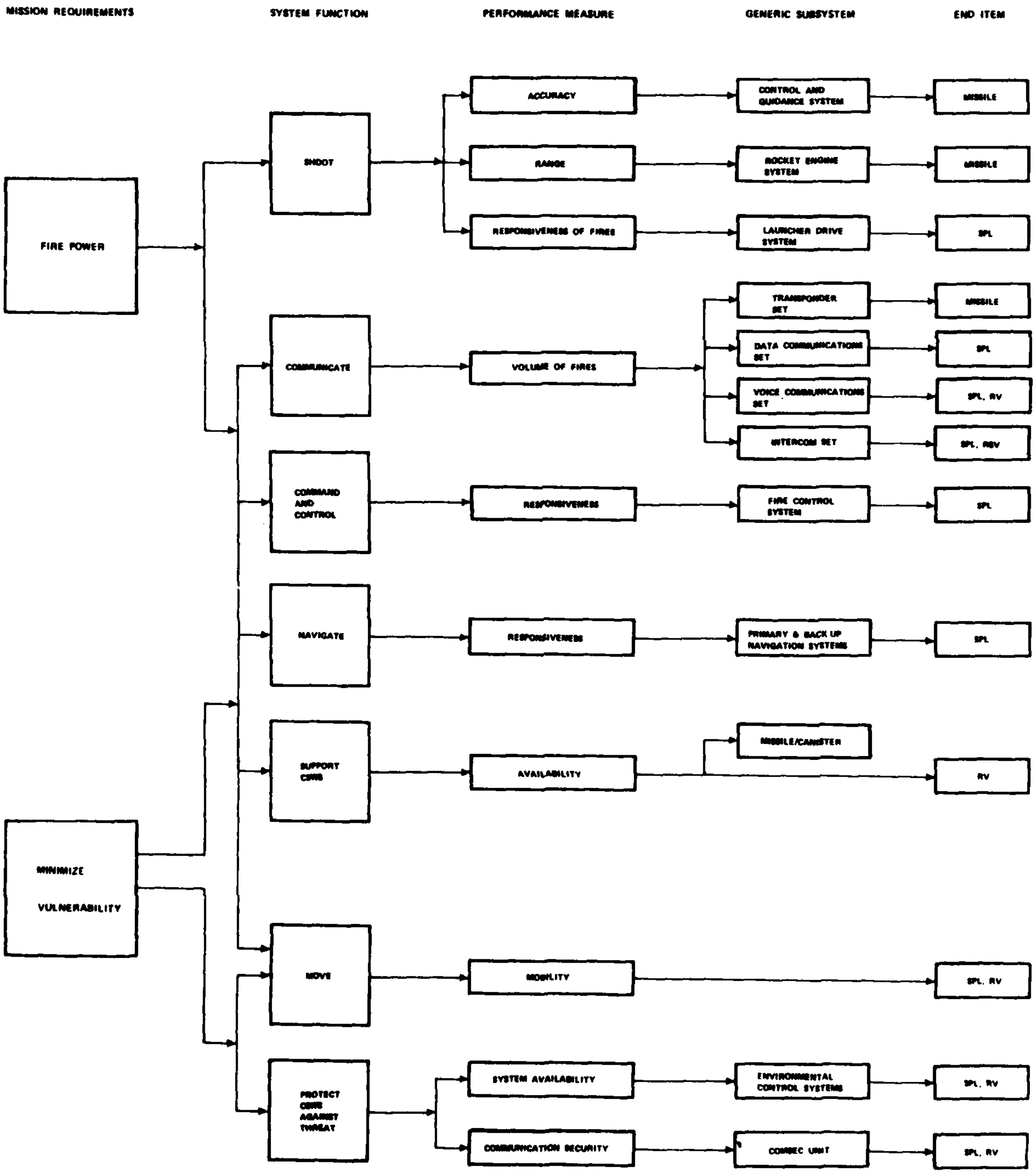
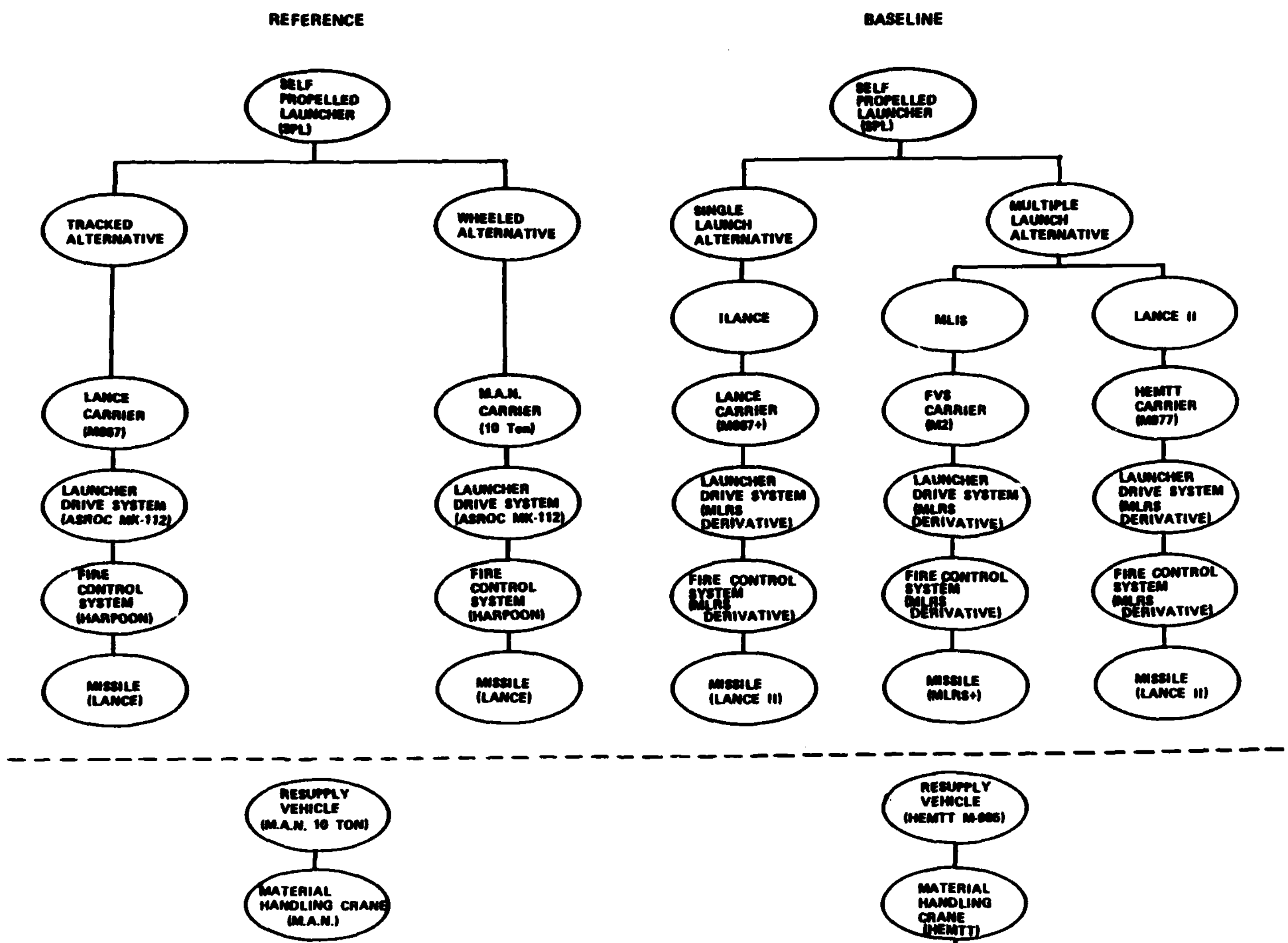


Figure 3-3. CSWS SYSTEM DESCRIPTION.



Configurations:	IL	-	Improved LANCE. Single launch alternative (1 LANCE II Missile)
	MLIS	-	Multiple Launch Interdiction System (3 Missiles).
	LANCE II	-	Multiple Launch Alternative (3 LANCE II Missiles).
Equipments	FVS	-	Fighting Vehicle System
	HEMTT	-	Heavy Expanded Mobility Tactical Truck
	MLRS	-	Multiple Launch Rocket System

3.3.2 Engineering Analysis

3.3.2.1 System Description

The available information on the three CSWS baseline concepts was sufficient to formulate the system functional requirements discussed in Section 3.3.1. To conduct the engineering comparability analysis, a notional reference system had to be created. As defined in the HARDMAN methodology, the reference system is comprised of fielded equipment with mature RAM data. The ability to cross service boundaries in search of the optimal reference system further demonstrated the versatility and validity of HARDMAN analysis techniques. The CSWS reference and baseline systems are illustrated in Figure 3-3.

Specific differences between the CSWS notional reference system and the three baseline alternatives are numerous and fall into three categories: (a) differences in equipment performance requirements, (b) differences in deployment scenarios and (c) differences in maintenance and logistic support concepts. The differences were mainly the result of service dissimilarities and the tracked versus wheeled vehicle concept comparisions. These main differences were the prime focus of the engineering analysis.

Equipment configuration data were collected for each sub-system identified for the study. Complete reference and baseline system lists can be found in Appendix A 2.2.

The reliability, availability and maintainability (RAM) data collected for the reference system component proved to be very consistent and reliable, due to their relative maturity. This was important to the application because the RAM figures directly relate to operator and maintainer workload as calculated during the Manpower Requirements Analysis.

3.3.2.2 Equipment Analysis

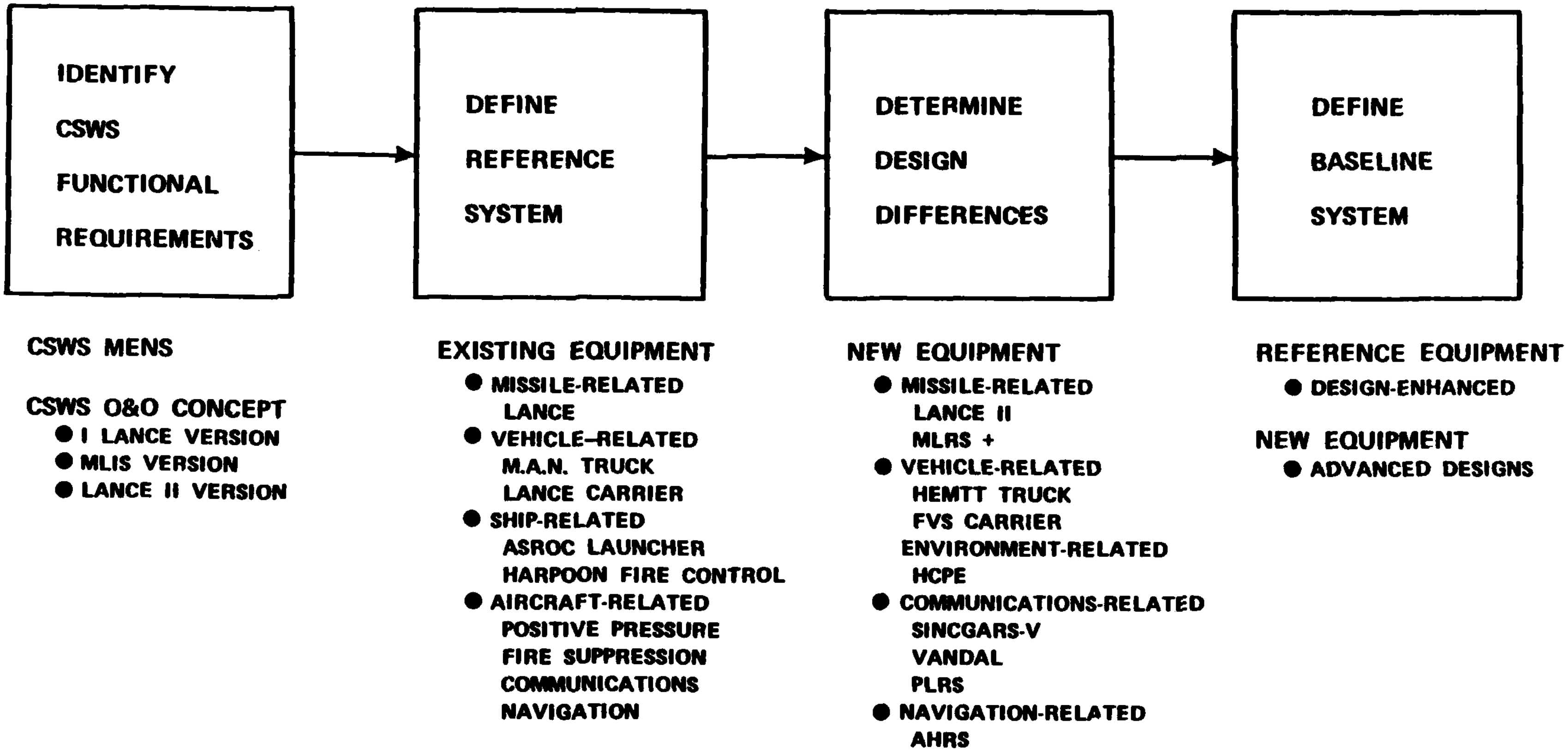
Overview

The front-end engineering analysis conducted in conjunction with the HARDMAN methodology was accomplished through the use of the comparability analysis technique. This analytic process was iteratively applied to equipments/systems encompassing a wide range of technologies and operating environments. Functional differences in capability between existing equipments/ systems and the requirements for the proposed CSWS systems were identified with this technique. Further analyses highlighted design differences and the necessary capability improvements. Figure 3-4 displays this analytic process.

General systems/subsystems configurations for the reference and baseline SPL and RSV systems were developed utilizing a mix of generic equipments from a variety of military sources. Tables 3-1 and 3-2 depict the derivative weapons platforms used in the CSWS engineering process that provided the equipments for the two reference and three baseline systems. Equipments were chosen for incorporation into the CSWS baseline or reference systems based on suitable RAM data being available and meeting the functional requirements. The type of RAM data, in order of preference, utilized for this equipment analysis were (a) field, (b) test, (c) design specifications, and (d) contractor projections.

The justification for use of non-Army systems/subsystems, i.e., naval ships and aircraft equipments, was based on the availability of quantitative and qualitative historical data resident in the Navy's Maintenance and Material Management (3-M) Data Reporting System. The use of non-Army systems/subsystems was predicated upon the availability of valid equipment and mature RAM data within the Army. In some instances, e.g., the launcher drive and navigation

Figure 3-4. System Analysis.



subsystems, mature technology was resident only in another service's equipment inventory. In other circumstances, significant RAM data voids were apparent due to the lack of an Army centralized Maintenance and Material Management (3-M) System or the Air Force's Maintenance Data Collection (MDC) System. The use of non-Army systems/non-systems was based upon their supportability by quantitative and qualitative historical RAM data from the respective service's maintenance data reporting source.

RAM Data Analysis

Corrective Maintenance (CM) workloads were developed for the reference and baseline systems using data obtained from Army, Navy and contractor sources. CM manhours for subsystems selected from Army equipment were obtained from the following data sources; sample data collection efforts (SDCs), Army Material Support Analysis Activity (AMSAA) studies, Army Tank and Automotive Command (TACOM) RAM-D Summaries and Army equipment specifications. CM manhours for Navy system components were derived solely from field data reported through the Navy's Maintenance and Material Management (3M) system and disseminated by either the Navy Maintenance Support Office (NAMSO) or the Navy Weapons Quality Engineering Center (WQEC). Contractor-projected CM manhours were used for baseline equipment systems for which CM maintenance data was not available in Army/Navy source documents. Tables 3.3 and 3.4 depict the applicable reference and baseline CM source documents with related equipment.

The following is a list of procedures utilized to assign CM workloads to the reference and baseline subsystems:

- CM hours were normalized to reflect a manhours per operating hours rate, i.e., a specific Maintenance Ratio (MR) for each equipment/system.
- whenever a standard MR could not be defined, equipment CM was expressed via a Mean Time To Repair (MTTR) rate, i.e., elapsed maintenance time (clock hours) per maintenance action.
- where CM hours for shipboard equipments could not be obtained, the standard Navy PM to CM ratios were used: 1:1 for electronic components and 2:1 for other type components.
- whenever contractor CM was utilized for baseline subsystems, viable reference CM data was identified and included in the analysis to provide a representative maintainability benchmark for comparative purposes.

Preventive maintenance (PM) workloads were developed for the reference and baseline systems using data obtained from Army, Navy and contractor sources. PM manhours for system components selected from Army equipment were primarily obtained from Maintenance Allocation Charts (MACs) published in Army Technical Manuals (TMs), both operational and organizational types. Additional Army PM sources were found in studies generated by the Army Material Support Analysis Activity (AMSAA), the RAM-D summaries published by the Tank and Automative Command (TACOM), and equipment specifications derived from new Army systems under development. PM manhours for system components selected from Navy equipment were obtained from such Navy source documents as Maintenance Requirements Cards (MRC) published by the Naval Air Systems Command, and Maintenance Index Pages (MIP) published by the Naval Sea Systems Command. Tables 3.3 and 3.4 display the applicable reference and baseline PM source documents with related equipment.

TABLE 3-1. REFERENCE SYSTEM DERIVATIVE PLATFORMS

REFERENCE SUBSYSTEMS	DERIVATIVE PLATFORM	EQUIPMENT NOMENCLATURE	MILITARY SOURCE
SPL:			
TRACKED CARRIER	LANCE	M667 CARRIER	ARMY
WHEELED CARRIER	MULTI-PURPOSE	M.A.N. 10-TON CARRIER	ARMY
ENVIRONMENTAL CONTROL			
o POSITIVE PRESSURE	E-2 AIRCRAFT	AIR CONDITIONING/ PRESSURIZATION SYSTEM	NAVY
o FIRE SUPPRESSION	E-2 AIRCRAFT	ENGINE & FUSELAGE FIRE DETECTION/WARNING AND FIRE FIGHTING SYSTEM	NAVY
o NBC PROTECTION	MULTI-PURPOSE[1]	M8, M42, M43, AN/PDR-27	ARMY
o DECONTAMINATION	MULTI-PURPOSE[1]	M11, M13 & M258	ARMY
COMMUNICATIONS			
o VHF-FM RADIO	CH-46 HELICOPTER	AN/ARC-131	MARINES
o COMSEC	CH-46 HELICOPTER	TSEC/KY-28	MARINES
o INTERCOM	CH-46 HELICOPTER	AN/AIC-14	MARINES
o DIGITAL DATA	E-2 AIRCRAFT	AN/ASW-25	NAVY
NAVIGATION			
o INERTIAL NAVIGATION	E-2 AIRCRAFT	AN/ASN-92	NAVY
o ATTITUDE HEADING REFERENCE	S-3 AIRCRAFT	AN/ASN-107	NAVY
o ALTIMETER	E-2 AIRCRAFT	AAU-19	NAVY
o DISTANCE TRANSMITTING UNIT	MULTI-PURPOSE	ODOMETER	ARMY

[1]Multi-purpose denotes equipment that is used on various types of platforms.

TABLE 3-1. (CONTINUED)

REFERENCE	DERIVATIVE PLATFORM	EQUIPMENT NOMENCLATURE	MILITARY SOURCE
LAUNCH FIXTURE	LANCE	LAUNCH FIXTURE	ARMY
LAUNCHER DRIVE	SHIPS	MK-112 ASROC LAUNCHER	NAVY
FIRE CONTROL	SHIPS	HARPOON FIRE CONTROL	NAVY
MISSILE ROUND	LANCE	GM52C	ARMY
MISSILE CONTAINERS	LANCE	M599, M596, M597	ARMY
RSV:			
WHEELED CARRIER	M.A.N.	10-TON CARGO TRUCK	ARMY
MATERIAL HANDLING CRANE	M.A.N.	MATERIAL HANDLING CRANE	ARMY
ENVIRONMENTAL CONTROL	SAME AS SPL CONFIGURATION		NAVY
COMMUNICATIONS	SAME AS SPL CONFIGURATION LESS AN/ASW-25 SET		MARINES

TABLE 3-2. BASELINE SYSTEM DERIVATIVE PLATFORMS.

BASELINE SUBSYSTEMS	DERIVATIVE PLATFORM	EQUIPMENT NOMENCLATURE	MILITARY SOURCE
SPL:			
TRACKED CARRIER	LANCE	M667 CARRIER	ARMY
	FIGHTING VEHICLE	M2 CARRIER	ARMY
WHEELED CARRIER	HEMTT	M977 VEHICLE	ARMY
ENVIRONMENTAL CONTROL			
o POSITIVE PRESSURE	UNDER DEVELOPMENT	HCPE	ARMY
o FIRE SUPPRESSION	E-2 AIRCRAFT	ENGINE & FUSELAGE FIRE DETECTION/WARNING AND FIRE FIGHTING SYSTEM	NAVY
o NBC PROTECTION	MULTI-PURPOSE[1]	M8, M42, M43 & AN/VDR-1/2	ARMY
o DECONTAMINATION	MULTI-PURPOSE[1]	M12, M13 & M258	ARMY
COMMUNICATIONS			
o VHF-FM RADIO	UNDER DEVELOPMENT	AN/VRC-( )4 SINCGARS-V	ARMY
o COMSEC	UNDER DEVELOPMENT	TSEC/KYV-4 VANDAL	ARMY
o INTERCOM	MULTI-PURPOSE[1]	AN/VIC-1	ARMY
o DIGITAL DATA	UNDER DEVELOPMENT	AN/VSQ-1 PLRS	ARMY
NAVIGATION			
o INERTIAL NAVIGATION	MULTI-PURPOSE[1]	AN/USQ-70 PADS	ARMY
o ATTITUDE HEADING REFERENCE	UNDER DEVELOPMENT	LR-80	ARMY
o DISTANCE TRANS-MITTING UNIT	MLRS	ODOMETER	ARMY

[1]Multi-purpose denotes equipment that is used on various types of platforms.

TABLE 3-2. (CONTINUED)

BASELINE SUBSYSTEMS	DERIVATIVE PLATFORM	EQUIPMENT NOMENCLATURE	MILITARY SOURCE
LAUNCH FIXTURE			
o SINGLE LAUNCH	LANCE	LAUNCH FIXTURE	ARMY
o MULTIPLE LAUNCH	SHIPS	HARPOON	NAVY
LAUNCHER DRIVE	SHIPS	MK-112 ASROC LAUNCHER	NAVY
FIRE CONTROL	MLRS	FIRE CONTROL	ARMY
MISSILE ROUND	UNDER DEVELOPMENT	MLRS+, LANCE II	ARMY
MISSILE CANISTER	SHIPS	HARPOON	NAVY
RSV:			
WHEELED CARRIER	HEMTT	M985 CARGO TRUCK	ARMY
MATERIAL HANDLING CRANE	HEMTT	MATERIAL HANDLING CRANE	ARMY
ENVIRONMENTAL CONTROL	SAME AS SPL CONFIGURATION		ARMY/NAVY
COMMUNICATIONS	SAME AS SPL LESS AN/VSQ-1 SET		ARMY
TRAILER	HEMAT	M989 TRAILER	ARMY

TABLE 3-3. REFERENCE SYSTEM RAM SOURCES.

SOURCE DOCUMENT	TYPE DATA	DERIVATIVE SYSTEM	REFERENCE SUBSYSTEMS
ARMY:			
LANCE SDC	CM	LANCE MISSILE	M667 CARRIER
			LAUNCH FIXTURE
			MAIN ASSEMBLAGE
			MISSILE SUPPORT ASSEMBLIES
			M39 HANDLING UNIT
TECHNICAL MANUALS	PM	LANCE MISSILE	M667 CARRIER
			LAUNCH FIXTURE
			MISSILE SYSTEM
			MISSILE CONTAINERS
			MISSILE SUPPORT ASSEMBLIES
AMSAA STUDIES	CM & PM	M.A.N. 10-TON VEHICLE	M.A.N. CARGO TRUCK
	CM	—	STE/ICE TEST EQUIPMENT
TACOM RAM-D SUMMARY	CM & PM	M.A.N. 10-TON VEHICLE	M.A.N. MATERIAL HANDLING CRANE
NAVY:			
3-M MAINTENANCE REPORTING SYSTEM	CM	CH-46 HELICOPTER	ARC-131 VHF-FM RADIO SET
			KY-28 COMSEC EQUIPMENT
			AIC-14 INTERCOM SET
	CM	E-2 AIRCRAFT	ASW-25 DIGITAL DATA COMMUNICATIONS SET
			ASN-92 INERTIAL NAVIGATION SET
			AAU-19 ALTIMETER AIR CONDITIONING AND PRESSURIZATION SYSTEM
			FIRE EXTINGUISHING SYSTEM

TABLE 3-3. (CONTINUED)

SOURCE DOCUMENT	TYPE DATA	DERIVATIVE SYSTEM	REFERENCE SUBSYSTEMS
3-M MAINTENANCE REPORTING SYSTEM	CM	S-3 AIRCRAFT	ASN-107 ATTITUDE HEADING REFERENCE SET
	CM	FFG-7 CLASS SHIP	ASROC LAUNCHER HARPOON FIRE CONTROL SET HARPOON MISSILE
AVIATION MAINTENANCE REQUIREMENTS CARDS	PM	A-4 AIRCRAFT	AIR CONDITIONING AND PRESSURIZATION SYSTEM FIRE EXTINGUISHING SYSTEM ARC-131 VHF-FM RADIO SET KY-28 COMSEC EQUIPMENT AIC-14 INTERCOM SET ASW-25 DIGITAL DATA COMMUNICATIONS SET
		F-14 AIRCRAFT	ASN-92 INERTIAL NAVIGATION SET
SHIP MAINTENANCE INDEX PAGES	PM	VARIOUS CLASS SHIPS DD-963 CLASS SHIP	ASROC LAUNCHER HARPOON FIRE CONTROL SET HARPOON MISSILE
CONTRACTOR:			
LANCE R/M REPORT	CM	LANCE MISSILE	WARHEAD SECTION MAIN ASSEMBLAGE MISSILE CONTAINERS

TABLE 3-4. BASELINE SYSTEM RAM SOURCES.

SOURCE DOCUMENT	TYPE DATA	DERIVATIVE SYSTEM	BASELINE SUBSYSTEMS
ARMY:			
LANCE SDC	CM	LANCE MISSILE	M667 CARRIER
			LAUNCH FIXTURE
			MISSILE SUPPORT ASSEMBLIES
TECHNICAL MANUALS	PM	LANCE MISSILE	M667 CARRIER
			LAUNCH FIXTURE
			MISSILE SUPPORT ASSEMBLIES
			HYBRID COLLECTIVE PROTECTION EQUIPMENT (HCPE)
	PM	FIGHTING VEHICLE	M2 CARRIER[1]
AMSAA STUDIES	CM & PM	M.A.N. 10-TON VEHICLE	M.A.N. CARGO TRUCK
	CM	– – –	STE/ICE TEST EQUIPMENT
	CM	FIGHTING VEHICLE	M2 CARRIER
	CM	– – –	VSQ-1 POSITION LOCATION REPORTING SYSTEM
TACOM RAM-D SUMMARY	CM & PM	HEMAT TRAILER	M989 TRAILER
EQUIPMENT SPECIFICATIONS	CM & PM	HEMTT VEHICLE	HEMTT MATERIAL HANDLING CRANE
	CM	– – –	VRC-( )4 SINCGARS-V VHF-FM RADIO SET
		– – –	KYV-4 VANDAL COMSEC EQUIPMENT

TABLE 3-4. C(CONTINUED)

SOURCE DOCUMENT	TYPE DATA	DERIVATIVE SYSTEM	BASELINE SUBSYSTEMS
NAVY:			
3-M MAINTENANCE REPORTING SYSTEM	CM	CH-46 HELICOPTER	AIC-14 (VIC-1) INTERCOM SET
	CM	E-2 AIRCRAFT	FIRE SUPPRESSION SYSTEM
	CM	E-2 AIRCRAFT	AIR CONDITIONING AND PRESSURIZATION SYSTEM (HCPE)
	CM	FFG-7 CLASS SHIP	ASROC LAUNCHER
			HARPOON FIRE CONTROL SET (MLRS)
AVIATION MAINTENANCE REQUIREMENTS CARDS	PM	A-4 AIRCRAFT	FIRE SUPPRESSION SYSTEM
			ARC-131 VHF-FM RADIO SET (SINCGARS)
			KY-28 COMSEC EQUIPMENT (VANDAL)
			ASW-25 DIGITAL DATA COMMUNICATIONS SET (PLRS)
SHIP MAINTENANCE INDEX PAGES	PM	VARIOUS CLASS SHIPS	ASROC LAUNCHER
		DD-963 CLASS SHIP	HARPOON FIRE CONTROL SET (MLRS)
			HARPOON CANISTER (LANCE II)
CONTRACTOR:			
CSWS PROPOSALS	CM & PM	—	USQ-70 POSITION AZIMUTH DETERMINATION SYSTEM
		—	LANCE II & MLIS MISSILES
EM-109 PROPOSAL	CM	—	LR-80 ATTITUDE HEADING REFERENCE SET

The definition of preventive maintenance varies over a range of source documents and maintenance philosophies. Certain assumptions were necessary to normalize the data and establish a common base for distribution of PM manhours. Following is a list of procedural assumptions utilized to assign PM manhours applicable to the systems/sub/systems of the CSWS equipment:

- daily PM requirements are performed by driver, operator and/or crewmen.
- periodic maintenance is performed at the organizational level and above.
- Navy PM hours predicated on an aircraft flight hour basis, or ship operating hour basis, were normalized to reflect PM hours per week, whenever feasible for Army equipments.
- of the ten maintenance or repair functions cited on Maintenance Allocation Charts, four functions (inspect, test, service, calibrate) were allocated to PM manhours. The remaining functions (adjust, align, install, replace, remove, repair) were deemed to fall under Corrective Maintenance (CM) categories.
- elapsed times cited on Maintenance Allocation Charts were assumed to exclude make-ready/put-away time as a portion of the total time allocated to perform the required maintenance function.

Carrier

Each of the three baselines employed a unique carrier for its Self-Propelled Launcher (SPL). What complicated the anaysis further was the tracked versus wheeled carrier comparison. The three baseline SPL alternatives are the 8x8 10 ton Heavy Expanded Mobility Tactical Truck (HEMTT) (wheeled) and two tracked vehicles: the new FMC-built Fighting Vehicle System M-2, and the current LANCE carrier, M667. Analysis of RAM data from currently fielded systems indicated that the type of carrier choice is between the greater mobility of a tracked vehicle or the higher maintainability (lower maintenance requirements) of wheeled vehicles. The serviceability improvements designed into the M-2 Infantry Fighting Vehicles and the enhanced mobility of the "all-terrain" HEMTT *illustrates* that the historical differences between the wheeled and tracked vehicles is closing. The proposed wheeled carrier in the LANCE II baseline is the new HEMTT, M977 version. This is a low-risk, non-developmental project. The Oshkosh Truck Corporation assembles the HEMTT using current commercially proven components. The HEMTT will provide dependable performance to the CSWS support concept as either the carrier or ammunition resupply vehicle. The tracked carrier alternatives present clear cut differences in design. The improved LANCE (ILANCE) baseline alternative uses the proven M667 LANCE Missile Carrier. This M113A2 derivative vehicle represents low design risk to the ILANCE baseline. The M667 design has been continuously improved and can be further updated through preplanned product improvement (P^3I) prior to CSWS initial operational capability (IOC). The basic M667 configuration however, presents larger manpower demands due to the increased number of systems on which preventive maintenance (PM) is required, i.e., the ramp, differential, and bilge pump; and larger Mean Time To Repair (MTTR) figures due to the bolted access doors and track shroud removal process.

The Multiple Launch Interdiction System (MLIS) baseline uses the chassis of the M-2 Fighting Vehicle System (FVS) as its missile carrier. The M-2 introduces new design features with a potential for significant MTTR and reliability improvements. The M-2's cab-over feature and the increased power train package flexibility will be the two factors most responsible for these improvements.

In summary, the three baseline proposals all include acceptable automotive carriers and missile resupply vehicles of generally low technological risk.

Missile

Missile equipment for the CSWS reference system essentially encompassed the LANCE missile as presently configured. This subsystem functionally served the same mission need as the proposed CSWS missile. In addition, the various ancilliary missile containers used to transport and store LANCE missile components were retained for the reference system. LANCE missile support assemblies were also utilized not only for the reference system RSV and SPL platforms but also in the baseline single launch alternative, ILANCE, on the SPL, RSV and trailer units. The selection of the LANCE missile and supporting components provided the opportunity to also determine impacts of a baseline design option predicated on the preplanned, product improvement (P^3I) process.

Corrective maintenance (CM) data for Crew Organizational and Direct Support maintenance were extracted from the Army's LANCE Sample Data Collection (SDC) effort covering a three-year period from 1972 through 1975. These data were supplemented with information from the ongoing LANCE Reliability Capability Reports compiled by Vought Corporation. Data from this source covered all LANCE field operations through June 1981. Preventive Maintenance (PM) was derived from the appropriate LANCE technical manuals for the missiles, missile containers and the missile support assemblies.

In the CSWS baseline configuration, two versions of the "certified round" concept were incorporated for the design of the missile round and canister. One version was selected as the end product of the P^3I process - the I LANCE design. The I LANCE design retained the LANCE launch fixture for single launched rounds and, hence, still required an uncanistered missile on the SPL, RSV and trailer units.

The missile canisters in the design were considered as "throwaway" storage and shipping containers and the missile round was assumed to be uncrated in the ammunition resupply area prior to loading on the RSV and trailer. The other design version for the multiple launch alternatives was a fully "certified round," where the canister was also the missile launch platform and the missile did not require uncrating.

Baseline CM was found only at the direct support level due to the advanced design concept of canistered missiles. Projected CM data were extracted from contractor proposals. Any PM requirements were envisioned to be comprised of visual missile/canister inspections and a short/no voltage test accomplished as part of the preoperative crew checks and as a semi-annual canister check at the direct support level.

The expected CM maintainability improvement for the CSWS missile subsystem (baseline designs versus reference designs) could only be measured through the mean time to repair (MTTR) rate because of reported data formats. The baseline missile/canister design had a projected MTTR of 0.14 clock hours per maintenance action, while the reference missile and container configuration displayed a MTTR of 1.10 clock hours per maintenance action. Thus, use of the "certified round" concept in the baselines provided a decrease in the MTTR rate of 87.3% over the reference missile subsystem.

Specific differences between the CSWS reference system and the three baseline systems are numerous and fall into three categories: (a) differences in equipment performance requirements, (b) differences in deployment scenarios and (c) differences in maintenance and support concepts. Many of the differences in the latter two categories arose from service dissimilarities in those cases in which reference system components were chosen from other than Army inventories. These occurrences were the target of close scrutiny during engineering analysis.

Launcher Drive System

Two Launcher Drive System (LDS) alternatives were examined for CSWS. An LDS which moves the launcher in both azimuth and elevation is being considered for use in the Improved LANCE (ILANCE) Single Launch CSWS baseline alternative. An LDS which only elevates the launcher is projected for use in both the LANCE II multiple launch and the Multiple Launch Interdiction System (MLIS) alternative baselines. The Navy Anti-Submarine Rocket (ASROC) system provided the reference system equipments for both variations of the CSWS LDS.

The operation and control of the ASROC Launcher MK112 Elevation and Train Drive Systems is similar to that of the MLRS LDS. Both systems are electronically controlled, hydraulically driven designs although the ASROC LDS is larger and more complex.

For the launcher drive system (LDS), comparability analysis was performed for both the train and elevation capable, and elevation only arrangements. The ASROC MK109 stand is similar in size and operation to the MLRS base assembly of the CSWS baseline. The major design differences between the reference and the baseline systems were the number of equipment components included in each configuration and in the LDS cooling system. The development of baseline workload data began with the identification of new equipment design feature and operation and support concepts which will affect manpower requirements. Such effects can be measured in quantity (reduced/increased task frequencies and times) and in quality (higher/lower/new skill level required). CSWS baseline equipment impacted reference system task times both quantitatively and qualitatively. A summary of the impacts is discussed below.

The ASROC elevation and train drive system include equipments that exceed the requirements of the CSWS LDS. A single electric motor, hydraulic pump and hydraulic reservoir will drive the CSWS LDS; there is one of each component for both the train and elevation functions in ASROC. Scheduled maintenance is not performed at the organizational level on these components; organizational corrective maintenance (primarily consisting of remove and replace actions) will be halved. ASROC train and elevation air drive motors and associated components provide a backup emergency drive system which is not required in the CSWS design. Likewise the ASROC train and elevation buffer systems were not included in the baseline configuration. This equipment reduction will result in a corresponding reduction in maintenance workload.

Even fewer equipments are required by the CSWS LDS configuration that only elevates the launcher. The functions of the MK107 stand training circle, bearings and roller path are deleted by this baseline arrangement, thus the associated workload can be eliminated. For the same reason, further workload reductions are achieved by removing the requirements for train drive equipments such as the position monitor, reduction gear/ pinion drive assembly, power drive amplifier, and the hydraulic motor manual backup.

The elevation and train capable, and the elevation only LDS baselines have some common design differences from the reference configuration. Both incorporate built-in test equipment (BITE) which will reduce corrective maintenance by early detection of potentially damaging operating conditions (e.g., low oil levels, engine overheating, etc.). Addition ally, the ASROC system utilizes a seawater cooling and auxiliary steam heating system which cannot be adapted to the CSWS. The MLRS compact, closed heat exchanger incorporated into the baseline LDS will require significantly less maintenance than the complex ASROC heating and cooling system.

Several of the design differences for the elevation and train capable LDS affect maintenance workload. The ASROC drive systems have a reduction gear/drive pinion mechanism which trains and elevates the launcher. The CSWS LDS will have a reduction gear/drive pinion train mechanism but will elevate the launcher with two hydraulically driven control actuators. Based on maintenance manhour (MMH) per mainten ance action (MA) data in the Vought Corporation's MLRS Maintainability Report, the two control actuators will reduce baseline maintenance workload.

Fire Control System

The SPL fire control system (FCS) identified for the three CSWS baselines is an MLRS FCS derivative. The MLRS FCS has a built-in computer and memory system utilizing permanently stored data and locally input data to compute missile ballistics for single and multiple aim point fire missions. Mission information input to the FCS can be accomplished automatically via radio data link or manually via keyboard. Among presently fielded fire control systems, the U.S. Navy HARPOON Weapon System (HWS) FCS is very similar, in both operation and configuration, to the MLRS FCS. The OW-79/USQ-63 Data Terminal Group performs automatic communication with the HWS FCS, equivalent to the MLRS radio equipment. Thus, HARPOON and the USQ-63 comprise the FCS components of the CSWS reference system. Figure 3-5 illustrates the parallel components of the reference and baseline systems.

Due to the similarity in functional requirements of the HWS and MLRS fire control systems, only two HARPOON components were not included in the CSWS FCS reference system. These were the Trainer Module SM-749T/SWG-1(V) and the Card Caddy Maintenance Kit MK 1801/SWG-1(V). The HARPOON Trainer Module would have provided an on-site training capability which is not required in CSWS. The CSWS maintenance and support concept will require minimal maintenance by the vehicle crew. For this reason, the Card Caddy was not specified for the SPL. Maintenance requirements at both the organizational and direct support levels, however, generated a reference system requirement for both a Card Caddy and Test Set-Simulator (TSS) TS-3632/DSM at each site.

The reference system task taxonomies/event networks, based on the CSWS deployment scenario and applied to the FCS, differ significantly from the HARPOON. The task taxonomies/event networks by which reference system workload data were later compiled, affected neither the configuration nor individual operator functions of HARPOON fire control components in the reference system.

The next substep in the engineering analysis process is to identify baseline equipment and design differences.

The only major change to the MLRS FCS in the CSWS baseline was the deletion of the boom controller mechanism which was not required for the canistered missile options examined.

Among the design differences within the fire control system were two major areas of expected equipment improvement. Those were data link communication and message processing, and the fire control computer and interfaces. A smaller, less capable communication processor will replace the OW-79/USQ-63 data terminal group data link transceiver. Similarly, the smaller, less capable MLRS Central Processor Unit (CPU) and CPU interface was included in the baseline system to replace the HARPOON Data Processor Computer (DPC) and Data Conversion Unit (DCU).

Another major area of design differences concerned operator functions. A comparison of reference and baseline FCS operator functions revealed that less operator intervention is required in the reference system to communicate fire control mission instructions, initialize the FCS, input target data, and initialize and fire missiles.

For the fire control system, the baseline task taxonomies/event networks were very similar to those for the reference system. Although most of the same tasks were required, the equipment was different. An example of one deleted task was the manual computation and input of target aimpoint corrections due to meteorological data. That task is performed automatically by radio in the baseline system.

Figure 3-5. CSWS Fire Control System.

HARPOON WEAPON SYSTEM REFERENCE	MLRS FCS DERIVATIVE BASELINE
DATA TERMINAL GROUP	COMMUNICATION PROCESSOR
HARPOON SHIP COMMAND – LAUNCH CONTROL SET (HSCLCS)	
WEAPON CONTROL CONSOLE	ELECTRONIC UNIT
LAUNCHER SWITCHING UNIT	LAUNCHER INTERFACE
LAUNCHER RELAY ASSEMBLY	FIRE CONTROL UNIT
CASUALTY PANEL	REMOTE FIRING UNIT
WEAPON CONTROL INDICATING PANEL (WCIP)	FIRE CONTROL PANEL (FCP)
TEST–SET SIMULATOR	SHORT–NO VOLTAGE TESTER

Improved reliability and maintainability can be expected in the smaller, less capable communication, data processing and digital interface equipments in the baseline fire control system As a result, maintenance workload, both scheduled and unscheduled, will be reduced. Reduced baseline maintenance on some components such as the Launcher Relay Assembly (LRA) and LRA-launcher interface is due to reduction in missile capacity from eight to three. Finally, the reduced maintenance task times resulting from fewer fans and filters in the baseline fire control cooling system were offset by the increased maintenance frequencies required by the dirtier operating environment of the battlefield.

As mentioned previously, operator functions in the HARPOON weapon system are very similar to the CSWS MLRS baseline. Physically, equipment configurations of the two systems differ in that operator interfaces in CSWS are consolidated into a fewer number of control consoles, operated from a single location (the SPL cab, except for remote operation). A significant change is anticipated in the mode of communication employed during a fire mission. While a HARPOON firing mission can be controlled digitally via The Navy Tactical Data System (NTDS), it normally is backed up with radio/telegraph (R/T) voice and hard copy printed communications. During a CSWS fire mission, the vast majority of communications will be accomplished digitally via the radio data link controlled at the Fire Control Panel (FCP).

Target data inputs from NTDS to the HARPOON Weapon System do not account for the effects of local meteorological conditions on missile balistics. The HARPOON fire control computer, in fact, does not compute aimpoint adjustments with the input of raw weather data. Aimpoint adjustments due to current weather conditions must be locally measured, computed with a hand-held programmable calculator and manually entered. In CSWS, the FCP operator will automatically enter meteorological data (MET) received by data link.

Fire control operator task times in CSWS will tend to be greater as a result of the more complex operator panel display and operator prompting routines. Data elements essential to controlling a fire mission are all continuously displayed for the HARPOON operator. Displays and data to support a HARPOON mission are maintained at other remote stations on a HARPOON firing ship. The CSWS FCP operator must sequence through a variety of displays to review all of the data which he must be aware of for each mission. To aid the control of a CSWS fire mission, communication and operator prompts are utilized. The prompting routines enhance fire mission control but increase the FCP operator task times over the HARPOON reference.

Average CSWS FCP operator task times per target fired upon are somewhat reduced by considering targets per fire mission. HARPOON can fire at only one target at a time, CSWS is capable of engaging multiple targets during a single mission.

The CSWS FCS also has an error and fault prompt routine. Sixty-four operator errors and equipment malfunctions can be displayed on the FCP. HARPOON has a less informative fault display, requiring more operator time to interpret and correct faults after initial alert. Resumption of normal fire control operation following a fault indication will be quicker in the baseline than in the reference.

Communications/Navigation

The reference equipment design for the vehicular CSWS communications/navigation (comm/nav) suite were found to be imbedded in existing aviation hardware designs. For this reason, the equipment analysis focused on these aircraft-related avionics subsystems for the reference system. Table 3-5 displays a typical communications and navigation package found in several naval airborne platforms as compared to the communications configuration envisioned for the CSWS surface platforms of the SPL and the RSV.

TABLE 3-5. COMMUNICATIONS/NAVIGATION SUITE COMPARISON.

TYPE COMMUNICATIONS	AVIATION CONFIGURATION	CSWS CONFIGURATION
VOICE (EXTERNAL)	AN/ARC-131 VHF-FM RADIO SET	AN/VRC-( )4 (SINCGARS-V) VHF/FM RADIO SET
VOICE (INTERNAL)	AN/AIC-14 INTERCOM SET	AN/VIC-1 INTERCOM SET
SECURE	TSEC/KY-28 COMSEC UNIT	TSEC/KYV-4 (VANDAL) COMSEC UNIT
DATA	AN/ASW-25 UHF DATA SET	AN/VSQ-1 (PLRS) UHF DATA SET
TYPE NAVIGATION		
PRIMARY – INS[1]	AN/ASN-92 INS	AN/USQ-70 PADS[3]
ALTERNATE – AHRS[2]	AN/ASN-107 AHRS	LR-80 AHRS
ALTITUDE	AAU-19 ALTIMETER	PLRS FUNCTION

[1] INS – Inertial Navigation Set

[2] AHRS – Attitude Heading Reference Set

[3] PADS – Position Azimuth Determination System

The aircraft types providing the reference comm/nav subsystems were selected because their standard flying environments (fixed wing aircraft carrier operations and rotary wing field operations) simulated the adverse operating conditions which could be expected during SPL and RSV operations.

Corrective maintenance (CM) data for reference comm/nav equipment were readily available through the historical data resident in the Navy's Maintenance Material Management (3M) reporting system. One year's accumulation of maintenance data, July 1980 through June 1981, was used to derive the comm/nav maintenance ratio by subsystem based on the number of flight hours reported during this period. Navy maintenance performed at the Organizational and Intermediate levels were assumed to equate to the Army's maintenance levels of Crew, Organizational and Direct Support. Crew-manned airborne platforms were used to provide the equivalent crew maintenance workload as defined for the Army maintenance task structure. This crew workload total was aggregated at the Organizational level in the Navy's 3-M reporting system. Preventive maintenance (PM) data for reference comm/nav equipment were developed from Navy Maintenance Requirements Cards (MRC). Navy MRC documents equate to Army MAC (Maintenance Allocation Charts) documents.

The baseline equipment configuration for the CSWS comm/nav suites were primarily derived from several Army systems under development, i.e., SINCGARS-V, PLRS, etc. Maintenance data to support their use in the equipment analysis were found in a variety of source documents.

Design differences between the baseline system's advanced comm/nav designs and the reference systems' fielded comm/nav equipment can be best addressed through a comparison of the respective corrective maintenance workloads (maintenance ratios) presented in Tables 3-6 and 3-7. In the case of the inertial navigation and attitude heading reference sets, contractor maintainability data were used and, as such, the projections for equipment RAM improvement were highly optimistic.

The baseline communications subsystem maintenance rate displayed a 65.6% decrease compared to that of the reference system. The maintenance improvement for the navigation subsystem was even more marked, a decrease in manhours per operating hour of 96.7%.

Environmental Systems

Environmental systems fall into two categories: NBC protection and fire suppression. The U.S. Army Chemical Laboratory, Aberdeen Proving Grounds, is developing hybrid collective protection equipment (HCPE) to provide NBC protection for crew enclosures of mobile tactical weapons systems. The inherent NBC protection gained by use of an HCPE (currently deployed on the M-1 tank) permit crew/operator personnel to perform in a shirt-sleeve environment within the crew enclosure of the vehicle. This will be accomplished through the use of:

- a filtered positive pressure crew compartment;
- ventilated face masks;
- and NBC protective clothing (for use outside the crew enclosure and/or contingency use in the event of protective equipment failure).

The Army currently has both a positive pressure system and a ventilated facepiece system. The positive pressure system purifies the air inside the vehicle while the ventilated facepiece delivers purified air only to the special headgear available to each crew station. The HCPE provides dual protection and precludes the failure of a combat mission as the result of contamination in one of the two systems. The HCPE disadvantages are the obvious increase in preventive maintenance

Table 3-6. COMMUNICATIONS DESIGN DIFFERENCES – MAINTAINABILITY.

FGC	SUBSYSTEM	REFERENCE SYSTEM EQUIPMENT	REFERENCE SYSTEM MAINTENANCE[1] RATIO	BASELINE SYSTEM EQUIPMENT	BASELINE SYSTEM MAINTENANCE RATIO	DESIGN DIFFERENCE
24	COMMUNICATIONS					
2401	VHF-FM RADIO SET	ARC-131	0.126	SINCGARS-V	0.020	0.106
2402	COMSEC UNIT	KY-28	0.012	VANDAL	0.002	0.010
2403	INTERCOM SET	AIC-14	0.050	VIC-1[2]	0.050	––
2404	DIGITAL DATA COMM SET	ASW-25	0.062	PLRS	0.014	0.048
TOTAL			0.250		0.086	(–65.6%)

[1]Maintenance ratio values are given in manhours per operating hour.

[2]The Vehicular Intercom Set conceptualized as an ancilliary unit for the SINCGARS-V radios had no projected maintainability improvement factor. Therefore, the AIC-14 maintenance ratio was used as being representative of VIC-1 maintainability.

Table 3-7. NAVIGATION DESIGN DIFFERENCES – MAINTAINABILITY.

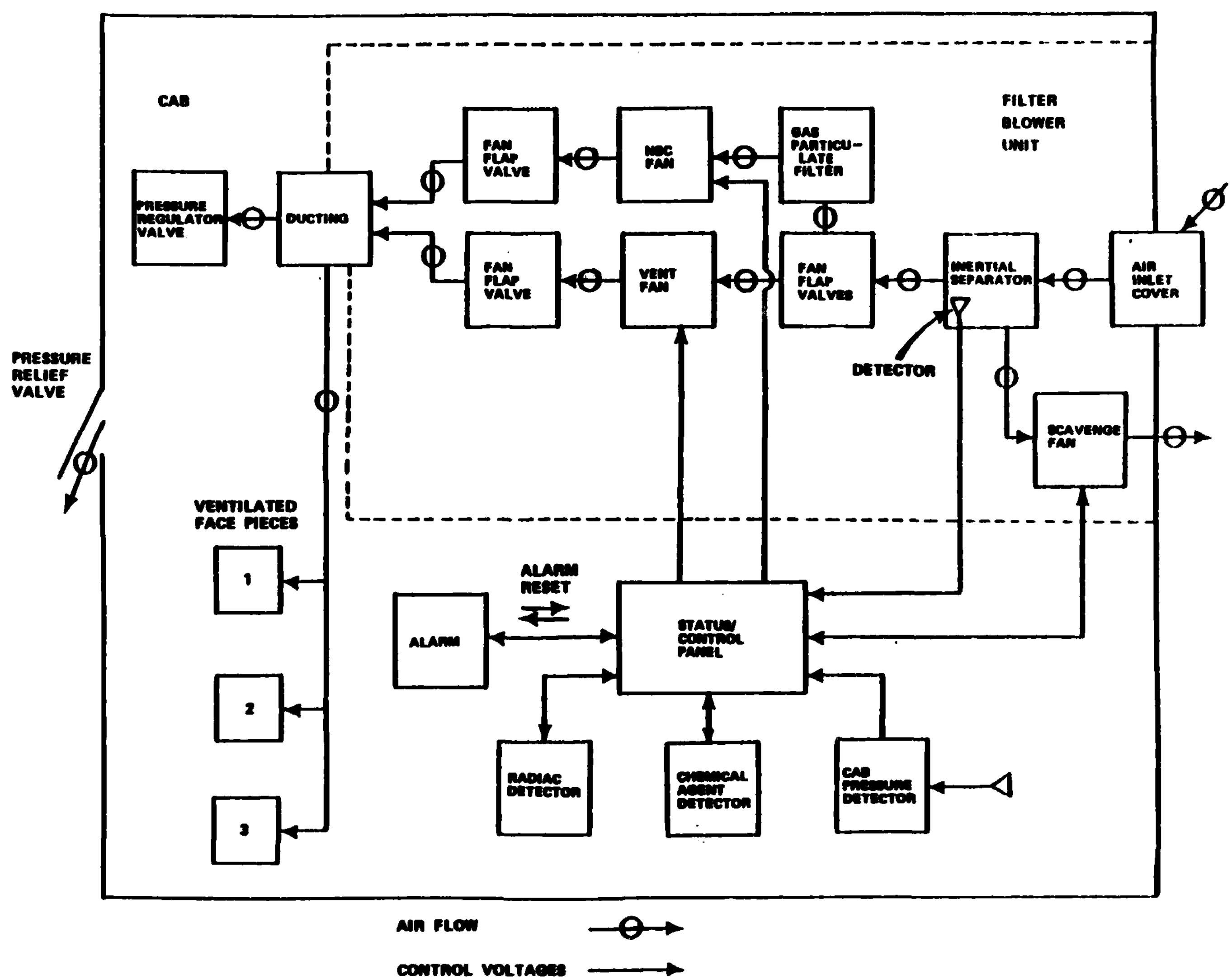
FGC	SUBSYSTEM	REFERENCE SYSTEM EQUIPMENT	REFERENCE SYSTEM MAINTENANCE[1] RATIO	BASELINE SYSTEM EQUIPMENT	BASELINE SYSTEM MAINTENANCE RATIO	DESIGN DIFFERENCE
25	NAVIGATION					
2501	INERTIAL NAV SET (INS)	ASN-92	0.651	USQ-70	0.024[2]	0.627
2502	ATTITUDE HEADING REFERENCE SET (AHRS)	ASN-107	0.210	LR-80	0.005[2]	0.205
2503	ALTIMETER	AAU-19	0.027	NA[3]	NA	0.027
2504	DISTANCE TRANSMITTING UNIT	ODOMETER	––	––	––	––
TOTAL			0.888		0.029	(–96.7%)

[1]Maintenance ratio values are given in manhours per operating hour.

[2]The maintenance ratio (MR) for the USQ-70 INS and the LR-80 AHRS were derived from contractor's projections. The INS value seems to be optimistic with the USQ-70 being a derivative of the ASN-92 family of INS. The AHRS value is reasonable given the strap down technology versus gimballed design.

[3]Baseline altimeter function assumed by PLRS pressure transducer unit. Maintainability data for this unit is embedded with PLRS maintenance ratio.

Figure 3-6. Hybrid Collective Protection Equipment.



required and the loss of usable space taken up by the two systems. Incorporation of a similar system in military adaptions of commercial trucks is planned but may require sealing design improvements to provide air-tight cab enclosures.

NBC protection for the CSWS baseline vehicles will probably be met by use of an HCPE adaptive system, enhanced by special protective clothing and radar detectors for use under extraordinary circumstances. Figure 3-6 depicts equipments that meet functional requirements for the CSWS SPL and RS.

Fire suppression functions required of the CSWS family of tactical vehicles dictates use of an automated non-toxic suppressant system. This will be coupled with reliable detection equipment suitable to combat petrochemical fires within the engine and crew compartments.

The selected baseline equipment is an automated Halon 1301 extinguishing system.

Preventive maintenance (PM) requirements for the HCPE baseline system were derived from a Preliminary Maintenance Allocation Chart obtained from the U.S. Army Chemical Laboratory, Aberdeen Proving Grounds. Corrective maintenance (CM) manhours for the reference and baseline systems were derived from Navy maintenance data reported against aircraft positive pressure systems equipment, functionally equivalent to CSWS positive pressure protection requirements.

PM manhours for the CSWS Halon 1301 fire suppression system were derived from PM requirements allocated to functionally similar fire suppression equipment designed for engine and crew compartments of the Navy A-2E aircraft. CM manhours for the Halon 1301 fire suppression system analyzed for the CSWS baseline vehicles were derived from Navy maintenance data reported against the Navy A-2E aircraft automated fire detection/suppression system. Use of Navy maintenance data was predicated on the non-availability of mature Army data.

PM and CM data applicable to reference and baseline decontamination equipment and radiation detection devices could not be obtained. It was obvious, however, that both equipment systems would require both preventive and corrective maintenance. Corrective maintenance (i.e., repair) from the example of the reference equipment, is currently performed at levels above direct support, and hence is outside the scope of this study. It was felt by DRC analysts that the PM on these two items should place a real requirement for appropriate manpower at direct support and organizational levels. Without being able to quantify this requirement, it was assumed that appropriate personnel were required in minimum numbers (i.e., 1 per organizational, and 1 per direct support unit maintenance levels) for each of two MOS. Manpower, personnel and training requirements for these were then calculated.

PM and CM manhours allocated to HCPE equipments for the baseline system include manhours necessary to maintain air conditioning equipment coupled to the Navy A-2E aircraft positive pressure system. Current functional requirements for CSWS tactical vehicles do not include similar crew comfort features. Operations in actual or simulated NBC environments dictate the necessity for cooling ambient temperatures within a crew/operator enclosure. Historically, air conditioning equipment in Navy aircraft generate considerable CM manhours; thus the decison to include these hours in analysis of the HCPE NBC subsystem.

SECTION 4 - DETERMINE MANPOWER REQUIREMENTS

4.1 OVERVIEW

The Manpower Requirements Analysis (MRA) for the Corps Support Weapon System provided a projection of the operators and system maintenance manpower requirements from crew to direct support level. The initial manning requirements were based on one Self Propelled Launcher (SPL) and one Resupply Vehicle (RSV) for the two reference systems and each of the three baseline system configurations under study. These initial requirements were multiplied by the number of SPLs and RSV specified in the force structure assumptions provided by the CSWS Special Task Force (STF). These manning requirements are quantitative inputs to the personnel and training analyses steps of the methodology.

Figure 4-1 displays the basic MACRIT equation used to determine system manpower requirements at both a general level and with the specific types of data element inputs required by Army Regulation (AR) 570-2, *Organization and Equipment Authorization Tables: Personnel*. For the CSWS project, modifications to MACRIT procedures were confined to changing specific values of the inputs that produce the productive capacity data element in the MACRIT equation. These modifications, accomplished with information provided by the U.S. Army Logistics Center, Ft. Lee, Virginia, provide a more realistic estimate of productive capacity for personnel who operate and maintain the components within CSWS.

Due to differences associated with determining operational and maintenance requirements, it was necessary to determine each area separately and combine them to produce the total manpower requirements for CSWS. Before these separate processes for computing operational and maintenance manning requirements could be accomplished, preliminary information and assumptions common to and required by both processes had to be obtained or calculated. Section 4.2 contains a discussion of the required preliminary information and assumptions. The operational and maintenance manpower requirements determination processes are described in Sections 4.3 and 4.4, respectively.

4.2 INITIAL INFORMATION AND ASSUMPTIONS

Prior to the computation of operational and maintenance manning requirements, operational and maintenance workload and estimates of productive capacity for the individuals operating and maintaining equipment within CSWS reference and baseline configurations were needed.

Operational and maintenance workloads were the result of combining an operational scenario with the engineering analysis information for each system configuration. Engineering analysis outputs, consisting of reliability, maintainability, performance and operation information, were used to develop the set of Mission Event diagrams similar to the one displayed in Figure 4-2. These diagrams illustrated, for each vehicle in the system, the sequence of task groups required to accomplish a mission cycle. A set of Mission Event diagrams for each of the reference and baseline configurations was used to record minimum, maximum and average time to complete a task group. These diagrams are located in Appendix B1.

FIGURE 4.1 MACRIT CALCULATION

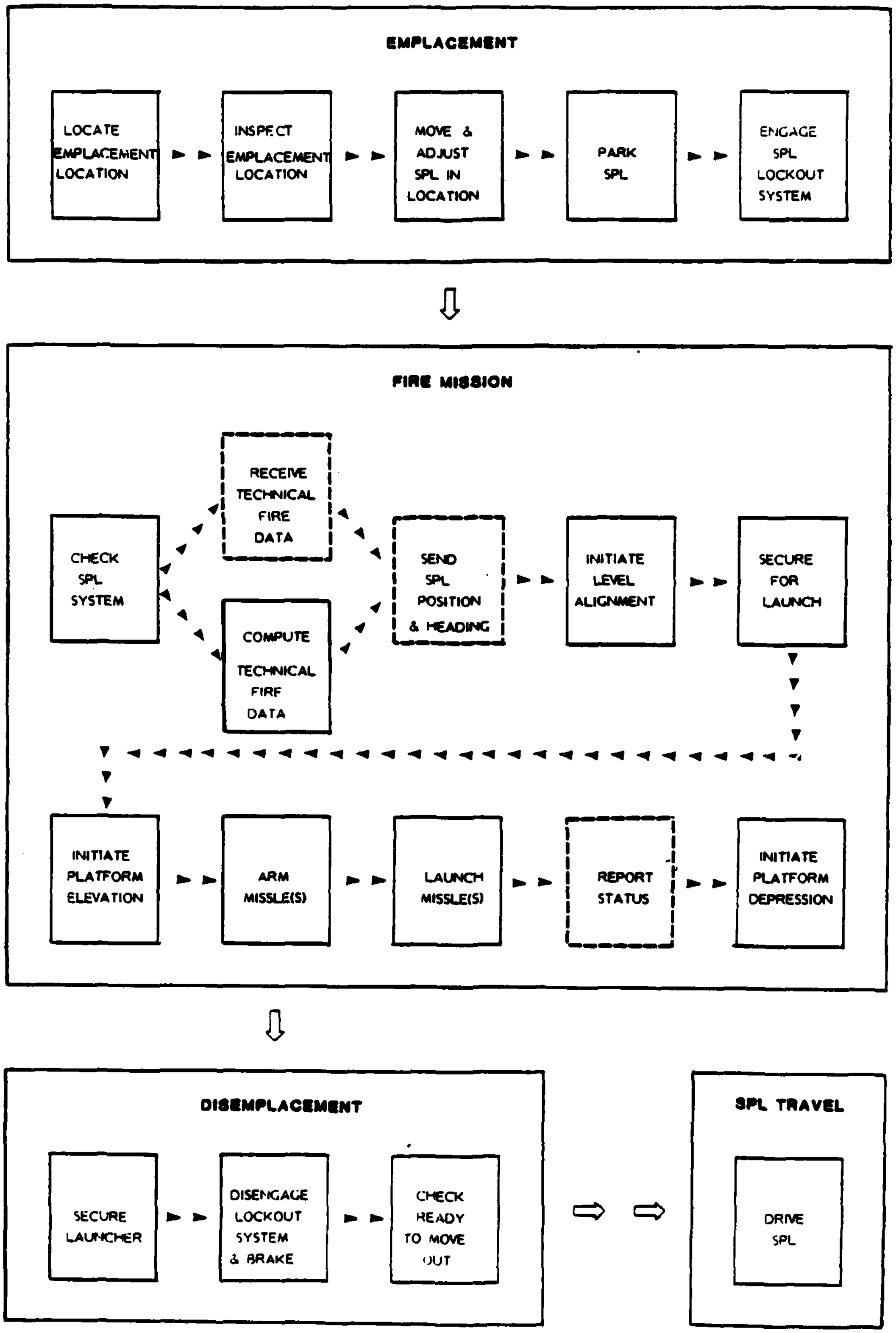
GENERAL:

$$\frac{\text{WORKLOAD} \times \text{FORCE STRUCTURE}}{\text{CAPACITY}} = \text{MANPOWER}$$

SPECIFIC:

$$\frac{\boxed{\begin{array}{c}\text{WORKLOAD} \\ \hline \text{MANHOURS} \\ \text{(DIRECT + INDIRECT} \\ \text{PRODUCTIVE)}\end{array}} \times \boxed{\begin{array}{c}\text{FORCE STRUCTURE} \\ \hline \text{SYSTEM} \\ \text{DENSITY}\end{array}}}{\boxed{\begin{array}{c}\text{CAPACITY} \\ \hline \text{PRODUCTIVE} \\ \text{MANHOURS}\end{array}}} = \begin{array}{c}\text{PERSONNEL} \\ \text{REQUIRED}\end{array}$$

Figure 4-2. Mission Event Diagram (SPL)



The operational scenario was constructed using information from the CSWS Operational and Organizational (O&O) Plan and the CSWS STF. A product of the scenario development was an automated matrix-based scenario model. This model, when loaded with mission requirements, task times from Mission Event diagrams, and system performance information provided a framework from which movement, launch, and resupply workloads for a specific CSWS configuration were calculated. The workload in hours, calculated by this model is a component in the construction of the Operational Manning Task Event Network used in Section 4.3.

Determination of the productive capacity of the individuals in CSWS was accomplished by constructing a working period based on mission requirements. For the purposes of this analysis, a seven day period was selected. This allowed for the calculation of a standard workweek, consisting of the elements shown in Table 4-1. This workweek and associated values were developed using MACRIT as a guide. The non-productive hours associated with messing and personal needs were factored out of time available for work. This decision was consistent with MACRIT methodology in that sleep is not considered by MACRIT as time available for work. Although unit movement, which includes tactical deployment was considered as a percent (from MACRIT) of the 84 hour workweek, it was examined to ensure the correctness of this percentage for use in CSWS. Because no assumption was provided as to the tactical movement of maintenance personnel (i.e., unit movement of battery and above), it was decided that for maintenance personnel, the percentage method was suitable. Regarding the system operator, however, the actual time required to perform tactical movement was significantly less than allowed for by the MACRIT percentage. To resolve this problem the time associated with performing this movement was classified as workload and not a percentage allowance. The end result is 84 and 63 hours of productive time per week for operators and maintainers respectively.

The remaining item of required initial information was the CSWS force structure assumption needed to aggregate the total manpower requirement. This information was supplied by the CSWS STF and is displayed in Table 4-2.

4.3 DETERMINE OPERATOR MANPOWER REQUIREMENTS

The first step in determining CSWS operator manpower requirements was to identify workload categories. The proper workload categories were those which existed in the projected mission environment and were necessary to fulfill required mission capabilities. CSWS operator workload categories were identified and defined as follows:

- **Operational Manning** (OM). Workload required to fulfill the mission capabilities of launching (SPL only), communication, resupply and mobility, to include emplacement, disemplacement, and transit.
- **Scheduled Maintenance** (SM). Workload measured in manhours required to maintain equipment or material in an operating condition.
- **Unscheduled Maintenance** (UM). Workload, measured in manhours, required to restore equipment or material to operating condition.
- **Preventive Maintenance Checks and Services** (PMCS). Same as SM, but event driven.

Based on this definition of CSWS operator workload and the definition of the operator workweek from Section 4.2 the operator manpower requirements equation was stated as:

$$\frac{\text{Workload}}{\text{Workweek}} = \frac{OM + SM + UM + PMCS}{84} = \text{Manpower}$$

TABLE 4-1. CSWS STANDARD WORKWEEK.

1. ANALYSIS OF AVAILABLE HOURS

TOTAL HOURS AVAILABLE WEEKLY		(24x7)	168
MINUS:	SLEEP	(8x7)	56
	MESS	(2x7)	14
	PERSONAL NEEDS	(2x7)	14
			84

2. PRODUCTIVE CAPACITY

OPERATORS (CREW):	AVAILABLE HOURS	84
	NO ALLOWANCES	0
PRODUCTIVE CAPACITY PER WEEK		84

NON-OPERATOR:	AVAILABLE HOURS	84
MINUS:	MOVEMENT ALLOWANCE	21
PRODUCTIVE CAPACITY PER WEEK		63

TABLE 4-2. CSWS FORCE STRUCTURE ASSUMPTIONS

LEVEL	REQUIREMENTS SPL	REQUIREMENTS RSV
PLATOON	2	2
BATTERY (3 PLATOONS PER BATTERY)	6	6
BATTALION (3 BATTERIES PER BATTALION)	18	18
CORPS (2 BATTALIONS PER CORPS)	36	36
TOTAL REQUIREMENT (ASSUME 5 CORPS)	180	180

The standard workweek and assumption set developed in 4.2 allowed computation of operator manpower requirement lower limits for the SPL and ARV. If the time available to work is 84 hours per week, and the greatest workload requirement calls for 24 hours per day or 168 hours per week, then the minimum manpower requirement is 2 personnel. Thus the aggregate manpower requirement for the workload categories must equal or exceed 2 for the SPL and RSV respectively.

The development of CSWS operator manpower for the reference and baseline systems began with extracting the operational manning (OM) workload from the scenario model for each reference and baseline configuration. Because SPL resupply was accomplished by the RSV crew, this workload was recorded as RSV and not SPL workload. The same principle was applied to the RSV resupply at the ammunition supply point which resulted in the omission of the workload for RSV resupply from the total RSV crew workload. Crew maintenance workload, SM, UM and PMCS associated with each system configuration were developed by identifying the system components requiring maintenance at the crew level. The crew workload from this process is displayed in Table 4-3.

These workload data were then formatted into the SPL and RSV crew task/event networks for the reference and baseline configurations. A task/event network is primarily a "bookkeeping" device. It has several distinct characteristics, most important of which are (1) the ability to support an audit trail, (2) the ready indentification of "high drivers," and (3) the ease with which the data may be reformatted to support different analytical processes. A sample task/event network is displayed in Figure 4.3. Task/event networks for all of the reference and baseline systems are contained in Appendix B3.

Crew workload displayed in the task/event networks was then aggregated by crew positions for SPL and RSV configurations. This workload is displayed in Tables 4-4 and 4-5 was then divided by the availability factor to produce the CSWS crew manpower requirements.

Because the Missile Handler (15XX, E3) has the primary responsibility for system maintenance, the maintenance workload in excess of the available hours of the driver position was assigned to a second Missile Handler position for the track reference and Improved Lance configurations.

The grade and skill level requirements were developed from criteria as outlined in the Enlisted Career Management Fields and Military Occupational Specialties (AR 611-201). Analyses of current skill level requirements in existing systems with independent operation capabilities were conducted to ensure an accurate estimate of skill level requirements.

Table 4-6 shows the CSWS crew manpower from this analysis.

4.4 DETERMINE MAINTAINER MANPOWER REQUIREMENTS

The development of maintainer manpower requirements was simplified in that only maintenance workload was considered. Workload categories of scheduled, unscheduled, and preventive maintenance checks and services were again utilized. The standard workweek developed in section 4.1 was used to ensure consistency in manpower requirements development.

Workload data, developed by the process described in section 4.2, were used in computing organization and direct support maintenance workload for each reference and baseline system configuration. These workload data were then aggregated by MOS and a productivitiy allowance of 40 percent was added to obtain the final number. This allowance is consistent with the

TABLE 4-3. OPERATIONAL WORKLOAD.[1]

SPL:	Reference		Baseline		
	Tracked	Wheeled	I Lance	MLIS	Lance II
1. DISEMPLACE	12.75	5.37	12.75	1.34	8.05
2. TRANSIT	9.37	6.59	9.37	5.17	8.02
3. EMPLACE	8.05	4.81	8.05	2.92	6.04
4. LAUNCH MISSION	7.01	7.01	9.39	4.29	6.69
5. MAINTENANCE	41.99	39.49	49.49	27.75	20.05
*6. COMMUNICATION	88.33	104.73	78.95	126.53	119.15
	168.00	168.00	168.00	168.00	168.00

RSV:	Tracked	Wheeled	I Lance	MLIS	Lance II
1. DISEMPLACE	1.73	1.73	1.73	1.73	1.73
2. TRANSIT	17.24	17.24	17.24	17.24	17.24
3. EMPLACE	1.30	1.30	1.30	1.30	1.30
4. RESUPPLY	59.03	16.34	52.99	12.75	35.46
5. MAINTENANCE	17.43	15.44	26.61	18.94	19.57
*6. COMMUNICATION	71.27	115.95	68.13	116.04	92.68
	168.00	168.00	168.00	168.00	168.00

*Communications workload that does not occur simultaneously with other workload.

[1]Workload displayed in hours.

Figure 4-3 SPL Task/Event Network (Wheeled Reference).

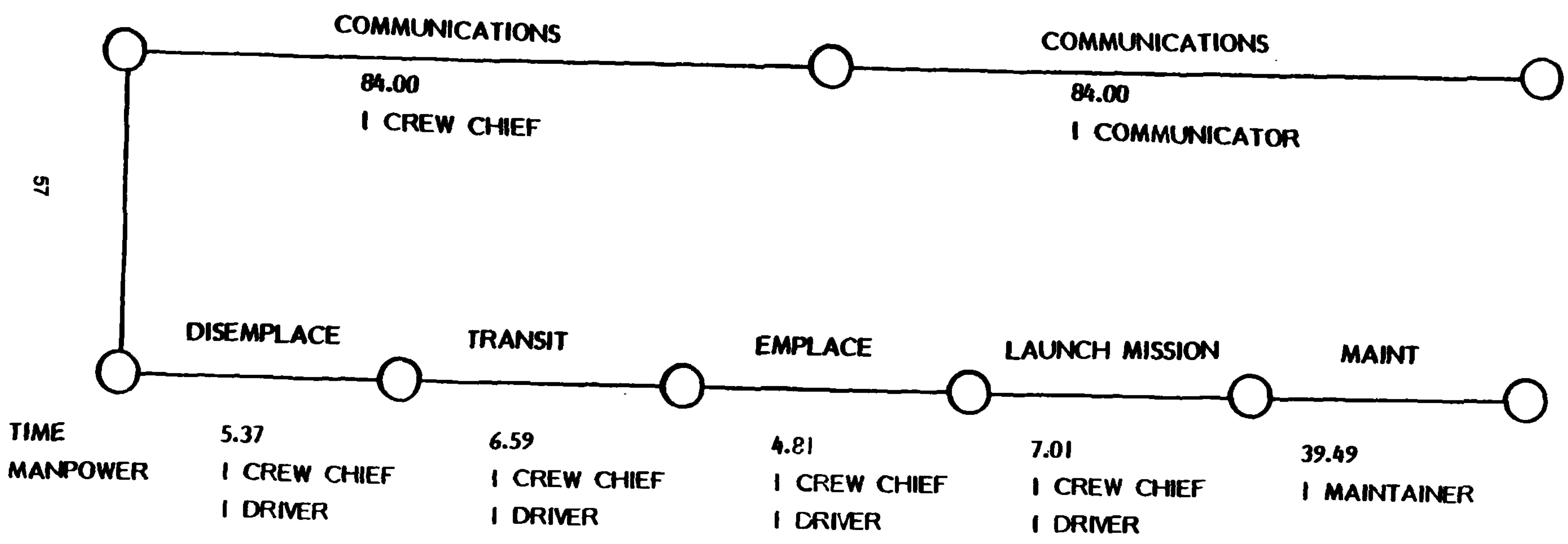


TABLE 4-4. SPL WEEKLY WORKLOAD BY CREW POSITION.[1]

	Reference		Baseline		
POSITION – TASK	Tracked	Wheeled	I Lance	MLIS	Lance II
SECTION CHIEF					
– DISEMPLACE	12.75	5.37	12.75	1.34	8.05
– TRANSIT	9.37	6.59	9.37	5.17	8.02
– EMPLACE	8.05	4.81	8.05	2.92	6.04
– LAUNCH MISSION	7.01	7.01	9.39	4.29	6.69
– *COMMUNICATION	46.82	60.22	44.44	70.28	55.20
	84.00	84.00	84.00	84.00	84.00
SPL DRIVER					
– DISEMPLACE	12.75	5.37	12.75	1.34	8.05
– TRANSIT	9.37	6.59	9.37	5.17	8.02
– EMPLACE	8.05	4.81	8.05	2.92	6.04
– LAUNCH MISSION	7.01	7.01	9.39	4.29	6.69
– MAINTENANCE	21.00	19.75	24.75	13.88	10.03
	58.18	43.53	64.31	27.60	38.83
MISSILE HANDLER					
– MAINTENANCE	20.99	19.74	24.74	13.87	10.02
– *COMMUNICATION	63.01	64.26	59.26	70.13	73.98
	84.00	84.00	84.00	84.00	84.00

*Communication Workload that does not occur simultaneously with other tasks.

[1]Workload displayed in hours.

TABLE 4-5. RSV WEEKLY WORKLOAD BY CREW POSITION.[1]

POSITION – TASK	Reference Tracked	Reference Wheeled	Baseline I Lance	Baseline MLIS	Baseline Lance II
SECTION CHIEF					
– DISEMPLACE	1.73	1.73	1.73	1.73	1.73
– TRANSIT	17.24	17.24	17.24	17.24	17.24
– EMPLACE	1.30	1.30	1.30	1.30	1.30
– RESUPPLY	59.03	16.34	52.99	12.75	35.48
– *COMMUNICATION	4.70	47.39	10.74	50.98	28.25
	84.00	84.00	84.00	84.00	84.00
RSV DRIVER					
– DISEMPLACE	1.73	1.73	1.73	1.73	1.73
– TRANSIT	17.24	17.24	17.24	17.24	17.24
– EMPLACE	1.30	1.30	1.30	1.30	1.30
– RESUPPLY	59.03	16.34	52.99	12.75	35.48
– MAINTENANCE	4.70	7.72	10.74	9.47	9.79
	84.00	44.33	84.00	42.49	62.45
MISSILE HANDLER 1					
– MAINTENANCE	8.71	7.72	13.30	9.47	9.78
– *COMMUNICATION	75.29	76.28	70.70	74.53	74.22
	84.00	84.00	84.00	84.00	84.00
MISSILE HANDLER 2					
– MAINTENANCE	4.65		2.57		

*Communication workload that does not occur simultaneously with other tasks.
[1]Workload displayed in hours.

Table 4-6. CSWS CREW MANPOWER (MOS 15XX) (1 SPL, 1 RSV).

			REFERENCE		BASELINE		
VEHICLE	DUTY POSITION	GRADE	TRACKED	WHEELED	I LANCE	MLIS	LANCE II
SPL	SECTION CHIEF	E-6	1	1	1	1	1
	SPL OPERATOR (DRIVER)	E-5	1	1	1	1	1
	SPL CREWMEMBER	E-4	1	1	1	1	1
RSV	ASSISTANT SECTION CHIEF	E-5	1	1	1	1	1
	HEAVY VEHICLE OPERATOR	E-4	1	1	1	1	1
	MISSILE HANDLER	E-3	2	1	2	1	1
	TOTAL		7	6	7	6	6

maximum allowed by MACRIT and is considered to be a valid estimate given the projected mission environment. The results of this aggregation are shown in Tables 4-7 and 4-8 for Organization and Direct Support maintenance echelons.

The development of an individual unit's maintenance manpower requirement was accomplished by multiplying the maintenance manpower per weapon by the weapon density, in this case 18 and 36 for the respective organization and direct support maintenance levels. Maintenance manpower was then determined by dividing the maintenance workload by the productive capacity developed in section 4.2. Fractional positions were rounded up to the next whole position to ensure all direct workload was covered. The 54E and 35H MOSs requirements were identified on the basis of new equipments incorporated into the CSWS reference and baseline configurations. However, no workload was identified for these positions. To fulfill the manpower requirement, one 54E and 35H MOS was assigned to the organizational and direct support maintenance levels respectively. Grade and skill level requirements for maintainers were determined for operators. A breakout of maintainer manpower by MOS and grade is not included here; it may be found in Appendix D1 as inputs to the IMPACT model.

A summary chart of CSWS manpower requirements for all of the alternatives is contained in Table 4-9.

TABLE 4-7. ORGANIZATIONAL MAINTENANCE MANPOWER (18 SPL, 18 RSV)

MOS	Reference Tracked	Reference Wheeled	I Lance	Baseline MLIS	Lance II
ASIXX	16	15	15	10	12
31V	12	12	5	5	5
52C	6	3	6	3	4
54E	1	1	1	1	1
63S	8	7	6	7	14
63Y	14	—	6	3	—
TOTAL	57	38	39	29	36

TABLE 4-8. DIRECT SUPPORT MAINTENANCE MANPOWER

(36 SPL, 36 RSV)

MOS	REFERENCE		BASELINE		
	TRACKED	WHEELED	I LANCE	MLIS	LANCE II
27B	25	19	23	11	20
31E	33	27	13	11	13
31S	1	1	1	1	1
35E	16	11	1	1	1
35H	1	1	1	1	1
52C	10	6	11	5	7
63G	2	5	1	1	2
63H	38	––	21	13	––
63J	9	7	15	10	12
63S	––	––	––	––	––
63W	30	50	31	22	36
TOTAL	165	127	118	76	93

TABLE 4.9. CSWS MANPOWER REQUIREMENTS SUMMARY.

(180 SPL, 180 RSV)

	TRACKED			WHEELED	
MOS	REFERENCE	I LANCE	MLIS	REFERENCE	LANCE II
CREW:					
15X	1260	1260	1080	1080	1080
MAINTENANCE:					
ASI	160	150	100	150	120
27B	125	115	55	95	100
31E	165	65	55	135	65
31S	5	5	5	5	5
31V	120	50	50	120	50
35E	80	5	5	55	5
35H	5	5	5	5	5
52C	110	115	55	60	75
54E	10	10	10	10	10
63G	10	5	5	25	10
63H	190	105	65	—	—
63J	45	75	50	35	60
63S	80	60	70	70	140
63W	150	155	110	250	180
63Y	140	60	30	—	—
TOTAL	2655	2240	1750	2095	1905
RATIO TO REFERENCE	—	.8404	.6591	—	.9093

SECTION 5
DETERMINE TRAINING RESOURCE REQUIREMENTS

5.1 OVERVIEW

This section describes the results of the Training Resource Requirements Analysis (TRRA) and outlines the general procedures that were employed in this analysis. It also describes the CSWS training resource requirements analysis and reports the findings and results of the analysis.

5.2 OBJECTIVES AND ASSUMPTIONS

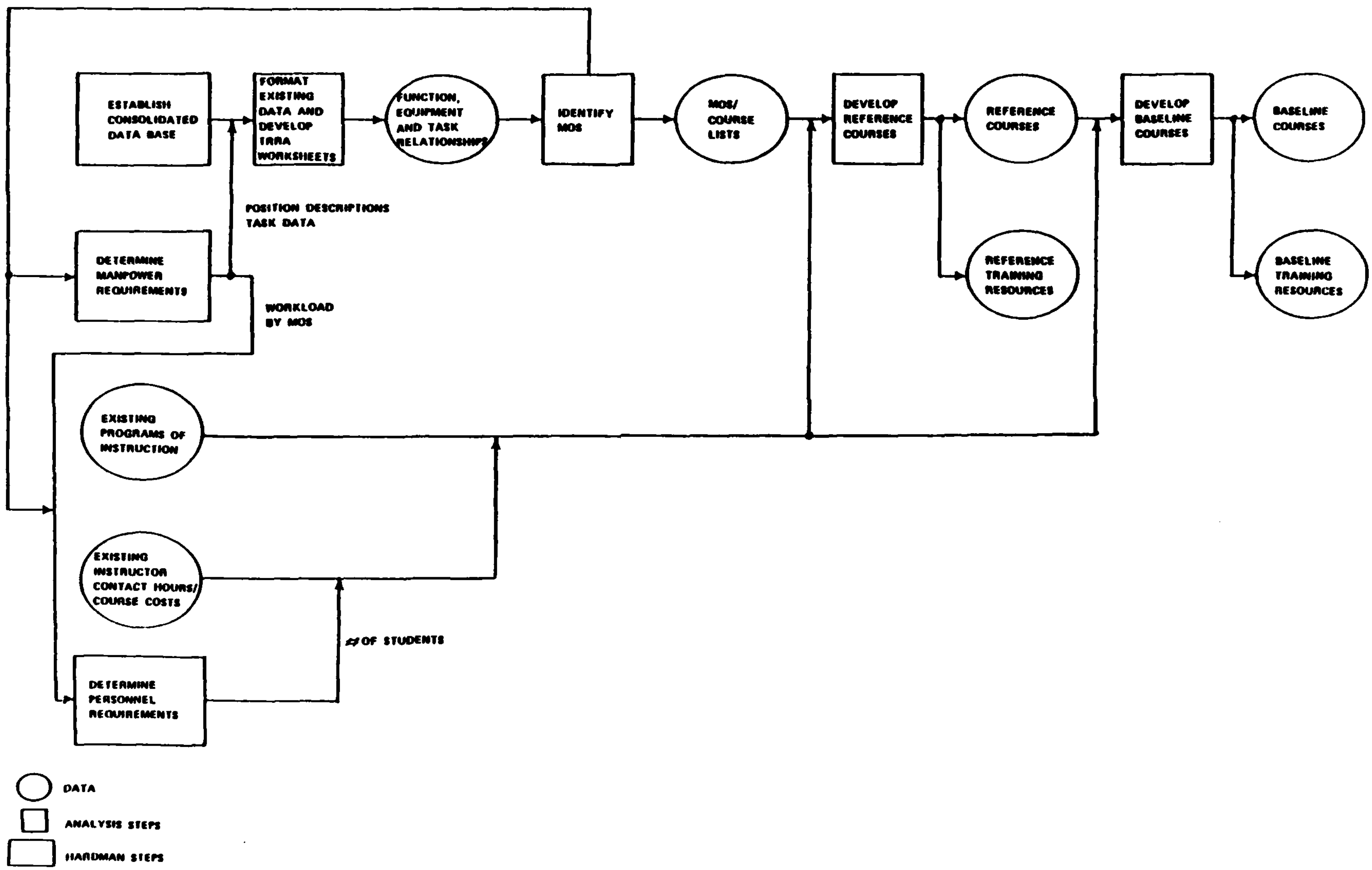
Like the other steps in the HARDMAN methodology, the TRRA is tailored to each analysis. This tailoring is based on the purpose and scope of the effort and the availability of data to support the analysis. The purposes of the CSWS analysis are discussed in Section 1 of this report. These objectives were further refined into the following TRRA objectives.

- Identify the entry level resident training requirements for the Corps Support Weapon System.
  - Identify courses impacted.
  - Identify course content and length.
  - Identify candidate training devices.
  - Identify instructor requirements.
  - Identify course costs.
- Establish the structure of the individual and collective task taxonomy for the Self-Propelled Launcher (SPL) and Resupply Vehicle (RSV) and document the relationship between collective tasks, equipment, and individual tasks for these vehicles.

The first objective supports the primary purpose of the HARDMAN methodology which is to influence design during the early phases of the system acquisition process. The second objective establishes an analytic structure which will support the development of the Outline Individual and Collective Training Plan (OICTP) for CSWS. This initial application is designed to lay the foundation for subsequent applications of the methodology. It is *not* designed to answer all of the early training estimation questions related to CSWS.

Two types of TRRA's can be conducted: general and detailed. These two types of training analysis differ in two ways. First, in a general TRRA only very general task and skill information is collected;

Figure 5-1. Training Resource Requirements Analysis (General TRRA).



while in a detailed TRRA more specific task data, at the task element level, are collected and subsequently analyzed. Second, in a general TRRA, baseline media are determined by analyzing existing courses and course modules. In a detailed TRRA, media are determined by applying a detailed algorithm to baseline tasks.

A general TRRA was conducted in this effort. This type of analysis was selected for the following reasons:

- The general analysis was commensurate with the research and TRRA objectives.
- CSWS is still in the early phases of the acquisition process and a detailed OICTP will not be required for some time.
- The equipment configuration and design information was at a general level of detail.[1]
- Sufficient detail exists in the existing course objectives to provide an initial task taxonomy.

The following assumptions helped to further define the general scope and focus of the TRRA.

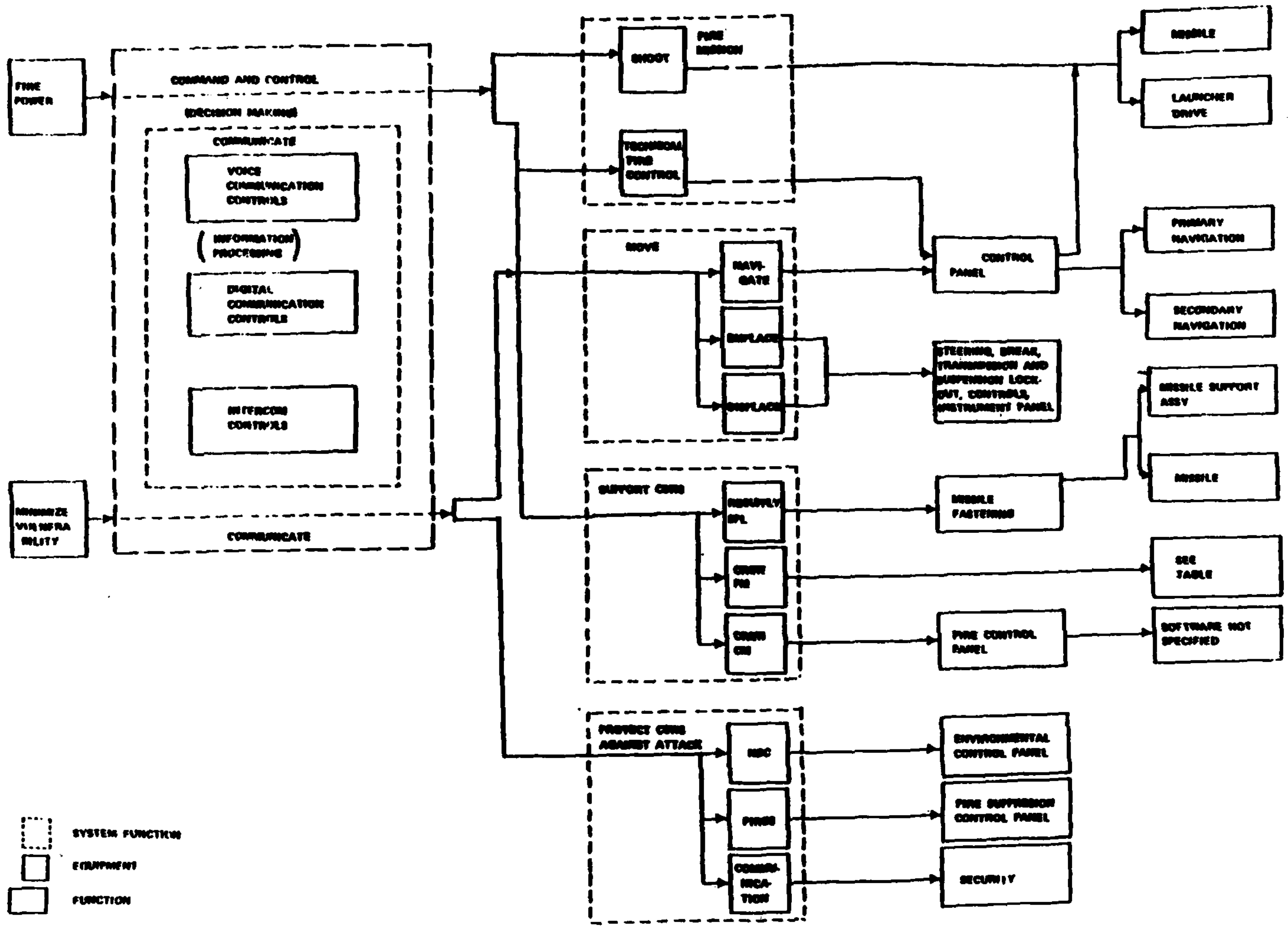
- Estimates in the TRRA are based on projections made from the existing subsystem, courses, etc., which most closely meet the functional requirements of the proposed system.
- Training resources and costs are estimated for the "steady-state" or average value year where the "steady-state" year is defined as the first year in which the Army training system is producing replacement training only (that is, all systems have been deployed and training is focused on filling billets vacated through attrition and promotion).
- Training associated with the operational test and evaluation of the proposed system and training associated with the initial fielding of the system (e.g., new equipment training) are not estimated.
- Only the resources and costs associated with entry level institutional training are estimated in the present version of the TRRA. Training resources and costs associated with unit training and advanced technical or NCOES training, Warrant Officer and Officer training are not estimated.
- Acquisition costs associated with the development of training products are not estimated.
- All established training is assumed in this iteration of the methodology to be adequately meeting existing system performance requirements.

5.3 TRAINING RESOURCE REQUIREMENTS ANALYSIS (TRRA)

Figure 5-1 shows the relationship between the general Training Resource Requirements Analysis (TRRA) and the other major steps in the HARDMAN methodology. Also shown are the general data inputs unique to the training resource requirements analysis, the steps in the analysis and the outputs of the TRRA.

[1] The engineering analysis was taken to a lower level to support the training requirements analysis. However, the design for the actual system is still at a conceptual level; program and design decisions are likely to have a significant impact on the detailed task taxonomy.

Figure 5-2. Baseline SPL Operation Analysis.



5.3.1 Format Existing Data and Develop TRRA Worksheets

Inputs for the Training Resource Requirements Analysis (TRRA) consisted of the system requirements, functions, and scenario data. This information was provided by the two previous steps in the analysis. The subsequent step, Personnel Requirements Analysis, exchanges information with the Training Resource Requirements Analysis in an interactive fashion by taking the MOS identified during the TRRA and providing the number of people who must be trained for the MOS. In addition, specific training related data are collected for the TRRA. Appendix A-3 contains a list of data sources which supported the CSWS TRRA.

Worksheets were developed to record the relationship between CSWS equipment and existing courses of instruction. (See Appendix C1). These worksheets are divided into two sets: one set to plan and document the analysis of system operation and the other to plan and document the analysis of system maintenance. This division was made because the requirements for system operator tasks are mission-based via the systems functional requirements. The equipment used by the operator to perform the system function is a means to this end. In comparison, maintenance task requirements are the result of equipment design and technology, hence, equipment design is an inherent component of maintenance tasks, rather than ancillary as in operator tasks. Figure 5-2, Baseline SPL Operation Analysis, and Figure 5-3, Baseline RSV Operation Analysis, show the relationships between mission requirements, functions, operator system controls, and vehicle subsystems in the operation of each vehicle.

5.3.2 MOS Assignment and Course Selection

The next step is the assignment of functions and equipment to MOS. This is treated as a separate analysis in Figure 5-1 because of the complexity of this decision. Some of the considerations involved are:

- Which MOS works on and is now receiving training in similar skills and knowledges.
- The branch of service of the existing MOS.
- The units the existing MOS is assigned to.
- Overtraining associated with the use of the MOS.[2]
- Historical precedent.
- Impacts on soldier career progression rates.
- The field unit workload requirements or equipment density and failure rate.
- The complexity of managing MOS assignments to field units.

Table 5-1 shows the CSWS MOS selected. Comparability analysis was used to identify or match MOS to function and equipment. In general, MOS were selected on the basis that training was already being provided on similar skills and knowledges. In the case of the CSWS Crewmember (15XX) and CSWS Mechanic (ASIXX), the decision was made based on the existing LANCE MOS structure. Initial MOS assignments were modified as the analysis progressed based on the information developed during subsequent analysis. Several potential problem areas have been identified related to MOS assignment. These are candidate areas for Tradeoff Analysis. All of the MOS assignments made for the CSWS are reported in Appendix C2. These MOS are inputs to Manpower Requirements Analysis.

[2] The term overtraining is used to denote training which is provided on a system which will not be used by the soldier when he is assigned to a field unit. This generally will be the result of equipment/duty position diversity within the MOS.

Figure 5-3. Baseline RSV Operation Analysis.

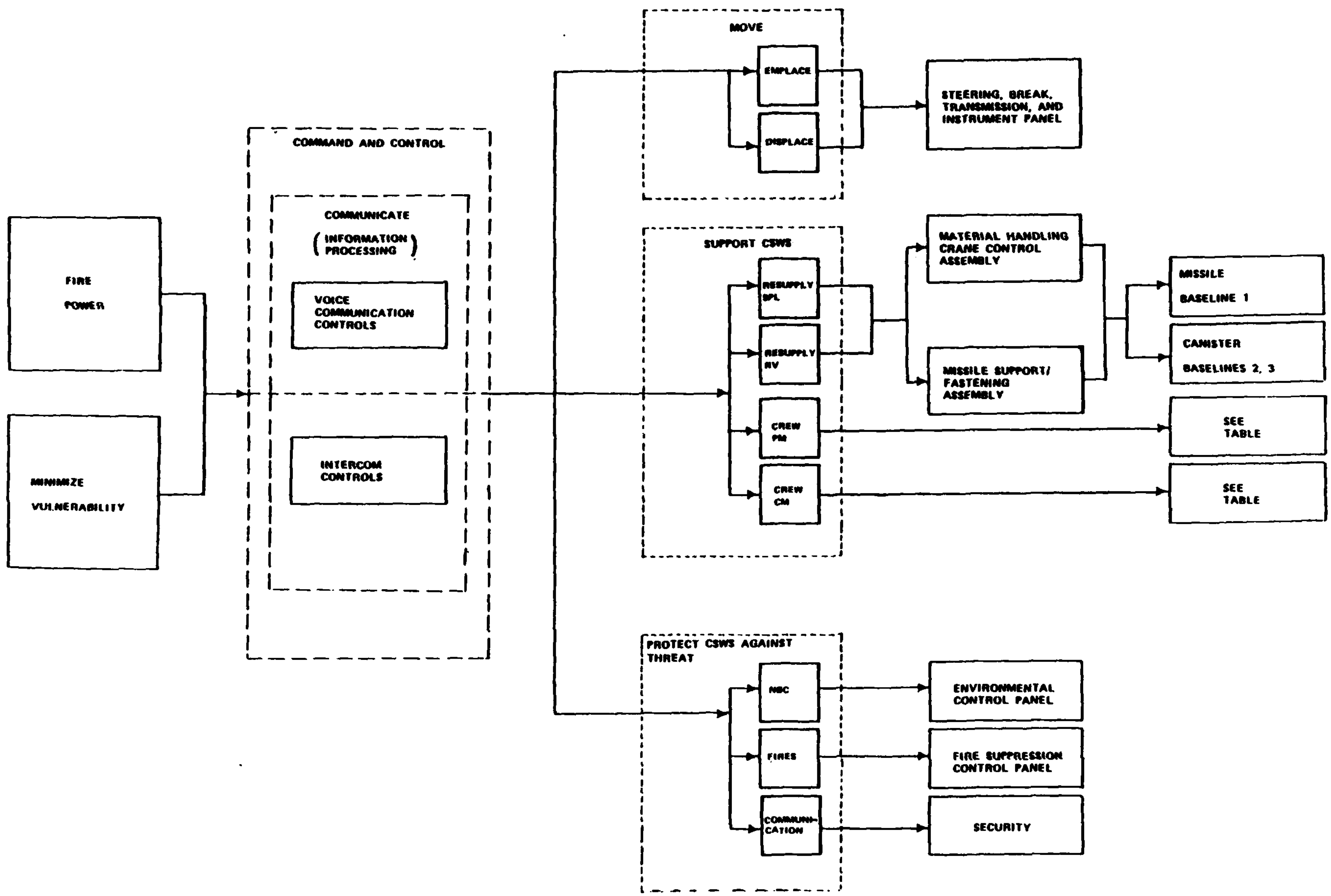


TABLE 5-1. SUMMARY OF CSWS MOS AND ASI ASSIGNMENTS.

MOS	TITLE (WITH ABBREVIATION)
15XX	CSWS CREWMEMBER (*)
ASIXX	CSWS MECHANIC (*)
27B	LAND COMBAT SUPPORT TEST SPECIALIST/LANCE REPAIRER (LCSS TEST SP/LANCE REP)
31E	FIELD RADIO REPAIRIER (*)
31S	FIELD GENERAL COMSEC REPAIRER (FIELD GEN COMSEC REP)
31V	TACTICAL COMMUNICATIONS SYSTEMS OPERATOR/MECHANIC (TAC COMM SYS OP/MECH)
35E	SPECIAL ELECTRONIC DEVICES REPAIRER (SP ELEC DEVICES REP)
35H	CALIBRATION SPECIALIST (*)
52C	UTILITIES EQUIPMENT REPAIRER (UTILITIES EQUIP REP)
54E	NBC SPECIALIST (*)
63G	FUEL AND ELECTRICAL SYSTEMS REPAIRER (FUEL & ELEC SYS REP)
63H	TRACK VEHICLE REPAIRER (TRACK VEH REP)
63J	QUARTERMASTER AND CHEMICAL EQUIPMENT REPAIRER (QM & CHEM EQUIP REP)
63S	HEAVY WHEEL VEHICLE MECHANIC (HVY WVEH MECH)
63W	WHEEL VEHICLE REPAIRER (WVEH REP)
63Y	TRACK VEHICLE MECHANIC (TRACK VEH MECH)

*Indicates no abbreviation.

5.3.3 Develop Reference and Baseline Courses

At this point the reference and baseline courses were developed. This is normally done with the use of course addition worksheets, which are used for new courses being developed and course modification worksheets, used for existing courses which are modified. Although two new MOS's were added for CSWS, an existing predecessor course was used as the initial basis for developing these reference courses. Table 5-2 shows these courses.

No course addition worksheets were used because predecessor courses were used for the TRRA.[3] All the CSWS course modification worksheets are contained in Appendix C3.

The selection of tasks for training was not explicitly performed or documented. It was assumed that tasks trained in the existing courses were appropriately selected. During the analysis, supporting course development task data were received for each MOS in the Soldier's Manual (SM) and Program of Instruction (POI). Two conditions were found which raised questions about the adequacy of the existing training for the CSWS.

(1) Equipment which do not have tasks listed in the Soldier's Manual (SM) because of low frequency.

(2) Equipment which have tasks listed in the Soldier's Manual (SM) with no training provided.[4]

Course data were used from the Multiple Launch Rocket System (MLRS) and the PATRIOT missile system to configure baseline courses. The data were not used in the reference system because these systems are new and the training proposed for them has not been validated. The MLRS was of particular importance for the development of the CSWS Missile Crewman Course (15XX) because of the increased mobility of MLRS over LANCE. This difference is reflected in the course design. Driving is taught in the MLRS course and not taught in the 15D course. In addition there was a change in the course philosophy between LANCE and MLRS. MLRS training does not teach crew procedures where LANCE does. This change was made in the baseline crewmember course.

When a detailed TRRA is done, SM task modifications, deletions, and additions are accounted for by task. In this effort; course modifications were accounted for at the level of course file numbers. The Course Modification/Deletion Codes used in the CSWS are shown in Table 5-3.

A major course modification results in the addition or deletion of prerequisite skills and knowledges, e.g. new modes of operation, new technology, and/or new mission procedures added or deleted. A minor course modification results in no significant change to the prerequisite skills and knowledges, e.g., equipment nomenclature changes or a change in mission with no change in mission procedures. Table 5-4 summarizes the CSWS course modification/deletions. These modifications will impact on the crew tasks by adding responsibility for the operation of

[3] Predecessor courses for the training requirements analysis were used to provide a training cost data base for these new courses and improve the audit trail for follow-on training effectiveness analysis. The TRADOC Systems Analysis Activity and the Training Effectiveness Branch at the Field Artillery School are conducting a study to determine the effectiveness of the existing 15D training. This study will contribute to a CSWS training effectiveness analysis. [4] In these cases the assumption is made that skills and knowledges taught on other tasks in the course are sufficient to support performance in the field.

TABLE 5-2. PREDECESSOR/CSWS COURSES.

PREDECESSOR COURSES	CSWS COURSES
15D LANCE MISSILE CREWMAN	15XX CSWS CREWMAN
ASIZ3 LANCE ORGANIZATIONAL MAINTENANCE MECHANIC	ASIXX CSWS MECHANIC

TABLE 5-3. COURSE MODIFICATION DELETION CODES.

EL	–	SUBSYSTEM ELIMINATED – MAJOR TASK IMPACT.
NC	–	NO CHANGE IN SUBSYSTEM – NO TASK IMPACT.
MIN	–	MINIMUM SUBSYSTEM/MISSION MODIFICATION – MINOR TASK IMPACT.
MAJ	–	MAJOR SUBSYSTEM/MISSION MODIFICATION – MAJOR TASK IMPACT.
ADD	–	NEW SUBSYSTEM ADDED – MAJOR TASK IMPACT.

Table 5-4. SUMMARY OF COURSE MODIFICATIONS DELETIONS.

MOS	REFERENCE COURSE FILES EL	MIN	MAJ	ADD	I LANCE COURSE FILES EL	MIN	MAJ	ADD	MLIS COURSE FILES EL	MIN	MAJ	ADD	LANCE II COURSE FILES EL	MIN	MAJ	ADD
15XX	2	1	10	12	0	19	7	1	5	7	6	1	7	11	5	1
ASIXX	1	5	2	2	1	5	2	2	2	3	6	3	2	3	3	3
27B	0	0	0	13	0	0	0	13	0	0	0	13	0	0	0	13
31E	0	0	0	10	0	0	0	11	0	0	0	11	0	0	0	11
31V	0	0	0	1	0	0	0	*	0	0	0	*	0	0	0	*
35E	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1
63H	–	–	–	–	0	0	0	10	0	0	0	10	–	–	–	–
63W	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	10

*The individual collective training plan for the position location reporting system assigns the training location for organizational maintenance in the unit.

communications equipment and the fire control computer and navigation systems to the existing responsibility of the CSWS Section Chief. These areas were included for training in the entry level training on the assumption that because of the small crew size (3 man) all crew members should have a minimal competency in operating all the major SPL sub-systems.

5.4 IDENTIFICATION OF TRAINING RESOURCES

There are many different ways to measure the resources required for training. The training resources which are measured are those which are required to produce "steady-state" replacement personnel. Training resources are estimated only for the system-specific courses. In the CSWS study, the term "system-specific courses" is used to refer to (a) the Advanced Individual Training (AIT) courses for all of the entry MOS associated with the operation of reference and baseline systems and (b) those resident maintenance courses providing specific instructions on CSWS equipment.

Four parameters were chosen to depict the training resource requirements for CSWS:

- Training Man-days - the length of time needed to train an individual.
- Instructors - the number of instructors required to conduct a course of instruction (COI).
- Course Costs - the amount of money required to train an individual.
- Training Devices - a list of candidate training devices for use in courses of instruction.

The selection of these parameters takes into consideration (1) the training data available for analysis, and (2) the level of meaningful training resource estimation needed to make decisions at this early stage in the acquisition process. As the CSWS system is further defined, subsequent iterations of the methodology allow for more detailed analyses of training resource requirements.

5.4.1 Determine Training Man-Days

The number of man-days required for training was obtained from the program of instruction (POI) for those courses that did not change and from the course modification worksheets found in Appendix C3 for those courses that did. Appendix C4.1 contains detailed breakdowns of training man-days by course and system for each MOS. Table 5-5 is a summary of the annual training man-day requirements for CSWS. The tracked reference system will have the largest total requirement for training time, while MLIS will have the least. ILANCE, however, had the greatest difference (W) from the existing courses, but was offset somewhat by a lower student level.

5.4.2 Determine Number of Instructors

Estimation of the number of instructors associated with the system-specific CSWS courses was determined by applying the algorithm found in the Staffing Guide for U.S. Army Service Schools (DA Pam. 570-558). Appendix C4.2 provides a detailed listing of the procedures and data sources used in developing the instructor contact hours for each course. The total, annual instructor contact hours provides the basis upon which the number of instructor requirements is determined.

Table 5-6 is a listing by system of the annual instructor requirements for CSWS. A significant difference in instructor requirements was found between systems. The overall range of instructor requirements varied from 91.6 for MLIS to 128.9 for ILANCE (a difference of 37.3 instructors) for the baseline systems. The average instructor requirements for the baseline systems are 108.7 versus an average of 147.8 for the reference systems. For all alternatives, MLIS is the least instructor intensive while the tracked reference is the most intensive.

Table 5-5. ANNUAL TRAINING MAN-DAY REQUIREMENTS (SUMMARY) BY MOS.

ANNUAL TRAINING MAN-DAYS BY SYSTEM

MOS	TRACKED REFERENCE		WHEELED REFERENCE		I LANCE		MLIS		LANCE II	
	Δ	PROPOSED	Δ	PROPOSED	Δ	PROPOSED	Δ	PROPOSED	Δ	PROPOSED
15XX	30307.	30307.	30307.	30307.	40246.	4024	40049.	40049.	33456.	33456.
ASIXX	5926.	5926.	5561.	5561.	5561.	5561.	265	2654.	3216.	3216.
27B	2040.	23528.	1575.	18165.	1890.	21798.	945.	10899.	1575.	18165.
31E	1270.	17145.	1190.	16065.	720.	6720.	615.	5740.	720.	6720.
31S	0.	585.	0.	585.	0.	585.	0.	585.	0.	585.
31V	143.	12571.	143.	12671.	0.	5200.	0.	5200.	0.	5200.
36E	1672.	21472.	1041.	13371.	21	2733.	213.	2733.	213.	2733.
36H	0.	80.	0.	80.	0.	80.	0.	80.	0.	80.
52C	0.	9747.	0.	5130.	0.	11457.	0.	4560.	0.	6897.
54E	0.	688.	0.	688.	0.	688.	0.	688.	0.	688.
63G	0.	1100.	0.	2200.	0.	550.	0.	550.	0.	1100.
63H	3673.	21852.	–	–	1970.	11721.	694.	6770.	–	–
63J	0.	2698.	0.	2318.	0.	5016.	0.	2698.	0.	3876.
63S	0.	5719.	1.	4773.	0.	3784.	0.	4773.	0.	9503.
63W	0.	14460.	4158.	29358.	0.	15120.	0.	11940.	1646.	19286.
63Y	0.	6798.	–	–	0.	3399.	0.	1353.	–	–
TOTALS	45031.	174676.	43976.	141172.	50600.	134658.	45170.	101272	40826.	111505.

TABLE 5-6. ANNUAL INSTRUCTOR REQUIREMENTS (SUMMARY) BY MOS.

	ANNUAL INSTRUCTOR REQUIREMENTS BY SYSTEM				
MOS	TRACKED REFERENCE	WHEELED REFERENCE	I LANCE	MLIS	LANCE II
15XX	22.6	22.6	31.4	31.1	25.2
ASI	7.3	6.9	6.9	3.2	3.9
27B	41.1	32.4	38.2	19.1	31.8
31E	18.0	16.9	7.1	6.2	7.1
31S	0.9	0.9	0.9	0.9	0.9
31V	11.3	11.3	4.6	4.7	4.9
35E	15.0	9.5	1.9	1.9	1.9
35H	0.1	0.1	0.1	0.1	0.1
52C	6.3	3.3	7.5	2.9	4.5
54E	0.8	0.8	0.8	0.8	0.8
63G	0.7	1.4	0.3	0.3	0.7
63H	15.5	0.0	8.3	4.7	0.0
63J	2.3	2.0	4.3	2.3	3.3
63S	3.9	3.3	2.6	3.3	6.5
63W	10.4	21.4	11.0	8.7	14.0
63Y	6.7	0.0	3.3	1.4	0.0
TOTAL	162.9	132.7	128.9	91.6	105.6

5.4.3 Determine Training Course Costs

Appendix C4.3 contains the procedures and algorithms used for making the training course cost determinations for each of the CSWS courses. Also contained in the appendix is a breakdown of all the per graduate costs for each course arranged by system. The total, annual training cost from the tables in the appendix were aggregated into Table 5-7.

As expected, the effect of adding additional students to most of the courses resulted in a decrease in the per student cost over the per student cost of the existing courses. For courses that resulted in increased per student costs, this was due to the addition of CSWS-specific instruction that was not offset by the addition of more students.

The most expensive system to train, is the tracked reference and the least expensive system is the MLIS. The annual cost difference between these two systems is $13,872,606.

5.4.4 Identify Candidate Training Devices

During the initial iteration of the TRRA, only general requirements for major training devices are determined, since these devices are the major drivers of media-related training costs. On subsequent iterations of the TRRA, requirements for other, less expensive media types can be identified. These more detailed media assignments can be made by using a series of algorithms to assign each of the modified/additional tasks to a specific media type.

Table 5-8 displays the general requirements for major training devices which were identified for the CSWS reference and baseline systems. (No differences in training device requirements were projected between the reference and baseline systems because of the small task differences associated with these systems.) For each type of training device requirement identified, Table 5-8 lists the type of personnel to be trained with each device (operator/maintainer); the type of device (where two different types of device options seem viable, both are listed); a description of the use of the device; and a brief listing of the existing devices which display some of the features needed for the projected device.

Again, it is important to note that Table 5-8 is only intended to identify the general requirements for training devices. The final determination of training device requirements cannot be completed until (a) the Self-Propelled Launcher and Resupply Vehicle hardware systems have been specified in greater detail, and (b) the staff at the appropriate schools and PM TRADE have had a chance to review and evaluate the initial list of training device requirements.

TABLE 5-7. ANNUAL TRAINING COURSE COSTS (FY82$).

ANNUAL TRAINING COSTS BY SYSTEM ($K)

MOS	TRACKED REFERENCE	WHEELED REFERENCE	I LANCE	MLIS	LANCE II
15XX	5,709	5,197	6,557	6,530	5,627
ASI	1,118	1,054	1,054	546	646
27B	4,137	3,351	3,886	2,225	3,351
31E	2,498	2,350	1,015	871	1,015
31S	78	78	78	78	78
31V	1,911	1,911	819	819	819
35E	4,297	2,840	312	652	652
35H	72	72	72	72	72
52C	2,342	1,303	2,702	1,168	1,713
54E	175	175	175	175	175
63G	295	580	149	149	295
63H	3,392	0	1,868	1,240	0
63J	575	500	999	575	797
63S	482	403	320	403	796
63W	3,726	5,411	2,978	2,368	3,672
63Y	1,175	0	595	239	0
TOTAL	31,982	25,225	23,579	18,110	19,708

TABLE 5-8. CSWS MAJOR TRAINING DEVICE CANDIDATES.

TYPE TRAINING	TRAINING DEVICE	TYPE	DESCRIPTION	COMPARABLE DEVICES
Operator	CSWS Crew Trainer	Embedded Crew Trainer	Provides CSWS crew training for fire mission and navigation procedures.	MLRS operational trainer with added navigation and digital communications capabilities. Patriot Operations Trainer (Proposed)
Operator	SPL Driver Trainer (Tracked) SPL, RSV Driver Trainer	3D Simulator	Provides training for drivers of the CSWS vehicles over a wide range of environmental and driving conditions.	XM1 Tank Trainer, Track Vehicle Trainer, M1 series Tank Driver Trainer (Proposed), MLRS Driver Trainer (Proposed)
Operator	Missile Handling Crane	3D Simulator	Provides RSV crew training for missile resupply operations.	(This may be the crane from the RSV)
Operator	Missile Support Assembly	3D Simulator	Provides RSV crew training for missile resupply operations.	(This may be the missile assembly from the SPL/RSV)
Operator/ Maintainer	Missile/Canister (Inert)	3D Simulator	Provides training for missile handling and organizational test procedures.	HARPOON Canister inert.
Operator/ Maintainer	CSWS Computer Operational Check and Fault Isolation Software	Completely Embedded Software	Provides training in the operational check and fault isolation of the SPL fire control computer, launcher drive, and missile for crew, organizational and DS/GS personnel.	PATRIOT maintenance trainer (proposed). Many other embedded software systems have this capability.
Maintainer	CSWS Electrical Hydraulic System Maintenance Trainer	Two-dimensional (2D) Programmable	Provides training in the function of the elevation and traverse drive systems electrical/hydraulic systems for both organizational and DS/GS personnel.	M60A1/A3 Tank Programmable Trainer and Erecter Launcher Simulator (DVC 06-46)
Maintainer	SPL Launcher Drive and Missile Support Hands-On Simulator	3D Simulator	Provides training in module/part location and removal and installation procedures for SPL organizational maintenance.	These types of simulators are included in the proposed Army Maintenance Training and Evaluation System which is being evaluated by the U.S. Army Ordnance and Air Defense Schools.

SECTION 6 - DETERMINE PERSONNEL REQUIREMENTS

6.1 OVERVIEW

The following section is a description of the HARDMAN Personnel Requirements Analysis (PRA). The purpose of the PRA is to estimate the number of personnel needed to sustain any one set of system specific manpower requirements, typically those of a single Military Occupational Specialty (MOS). Its major output is the number of personnel which must be trained per year to support manpower requirements. Its secondary output is a personnel structure.

It is important to note the difference between manpower and personnel requirements. A manpower requirement is a statement of the necessary numbers of people, described by MOS and paygrade needed to directly perform a specific set of mission-oriented tasks for a particular weapon system. A manpower requirement is calculated based on the workload required for the tasks. A personnel requirement is an estimate of the number of people carried within the MOS and paygrade to offset various losses from the manpower requirement over a specified period of time. During the standard time period, one year, it is assumed that there are no changes to a manpower requirement ("steady-state"); hence the personnel requirement is due solely to the structural imperatives of the personnel system.

Figure 6-1 illustrates the logic upon which the PRA is based. The PRA determines the size and structure of the personnel pipelines in steady state by estimating the losses that occur to a paygrade. Two main causes for MOS/paygrade losses are promotion and attrition. The promotion rate is the rate at which individuals advance from one paygrade to another; the attrition rate is the rate at which individuals leave a particular MOS/paygrade cell. Two types of attrition exist in the Army, MOS attrition (horizontal attrition) and Army attrition. Trainees, transients, holdees or students (TTHS) are non-active personnel and are classified as overhead. Individuals that fall into this category are not a direct loss to the Army or paygrade (since they may become active again), but a substantial loss to the operational force of that MOS/paygrade, therefore, they must be compensated for.

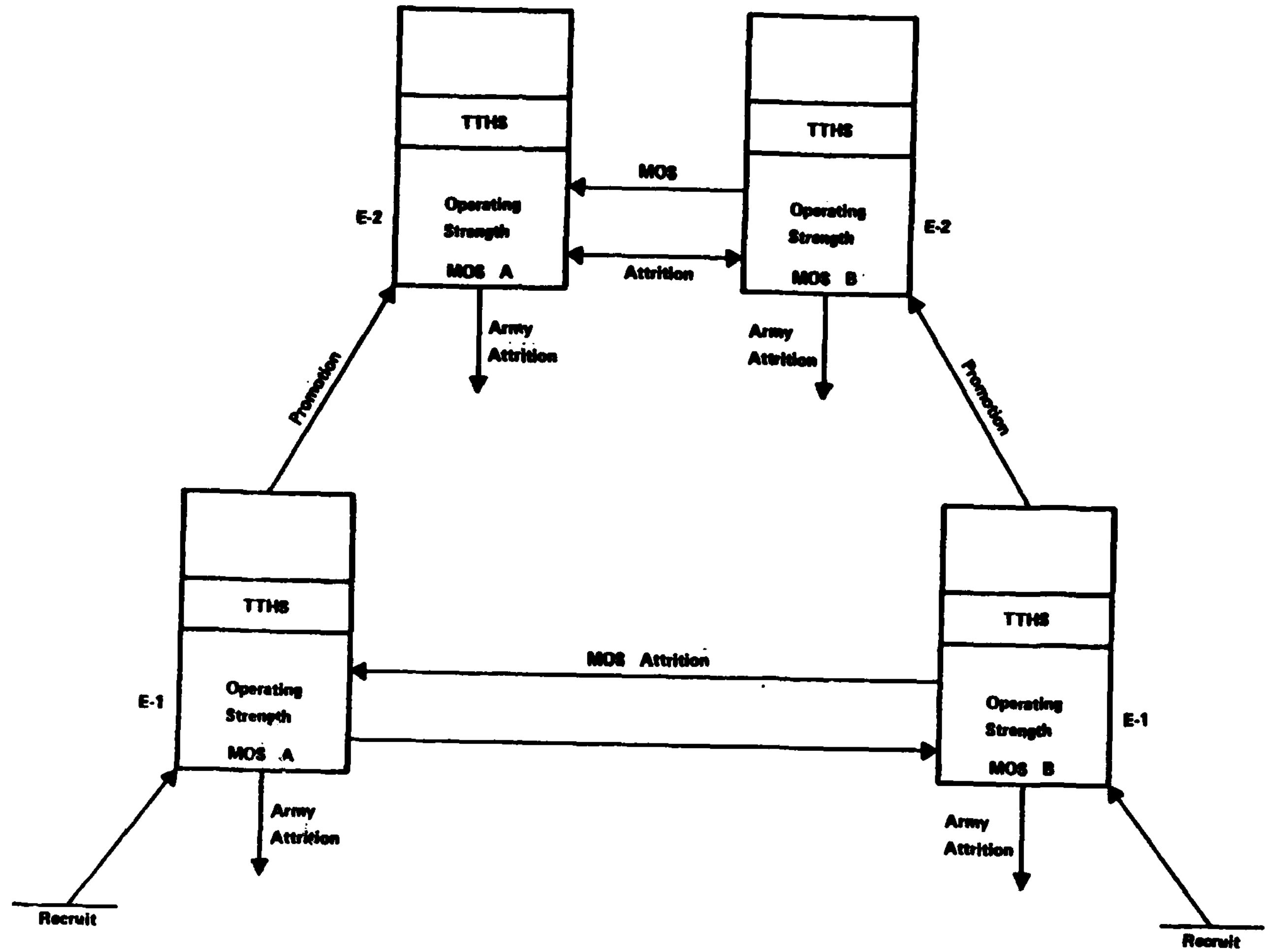
The Interactive Manpower-Personnel Assessment and Correlation Technology (IMPACT) Model was developed as a tool to determine personnel requirements given (a) manpower requirements, (b) promotion rates, (c) attrition rates and (d) TTHS percentage. The IMPACT model calculates the quantities of personnel needed to flow through each paygrade (9 paygrades) to sustain a certain level in each grade. Personnel must be promoted from below to fill replacements. For this reason, personnel requirements must be projected to allow for the growth necessary to satisfy current and future demands.

6.2 THE INTERACTIVE MANPOWER-PERSONNEL ASSESSMENT AND CORRELATION TECHNOLOGY (IMPACT) MODEL

6.2.1 Assumptions

- The IMPACT model is currently a system-specific personnel model which is driven by steady-state manpower requirements. Because of this, it is assumed that manpower requirements are already filled, and therefore, the personnel requirements represent the quantities and qualities of personnel which it takes to *sustain* these already-filled manpower requirements.

Figure 6-1. The Personnel Flow



- Historical rates are extracted and calculated from the Enlisted Master File (EMF), via the Defense Manpower Data Center (DMDC), for input to the IMPACT model. It is assumed that these input rates, or personnel flow rates, are accurate for their intended purpose.

6.2.2 Logic of the IMPACT Model

The concept which underlies the IMPACT model is the conservation of people. This means that the quantities of personnel which leave a particular paygrade must be replaced by personnel entering that paygrade. The IMPACT model determines the quantities of personnel needed in the personnel structure to support specified manpower requirements and to sustain itself so that the personnel structure can account for incurred losses. There are three input parameters to the IMPACT model. They represent reductions in the ability of a given total MOS/paygrade population to support its manpower requirement. These parameters are (a) promotion rates, (b) attrition rates, and (c) the percentage of the MOS/paygrade population in a trainee, transient, holdees, or student (TTHS) status at any given time. (Table 6-1). The IMPACT model's objective is to calculate the *minimum* amount of personnel needed at each level in the personnel structure. It is constrained so that each paygrade must support losses of the next higher paygrade, since replacements for these losses must be promoted from the paygrade below. The process will iterate several times before the optimal structure is established. Once each paygrade is able to support the paygrade above, it stops.

Personnel to be trained per year is the primary output parameter of the IMPACT Model. The quantities of personnel to be trained per year represent the flow through each paygrade due to yearly losses to the personnel structure and therefore, the flow through the training system. The parameter is split into the categories manpower losses per year, and overhead losses per year. Manpower losses are losses given promotion, attrition, and application of the TTHS percentage to the manpower requirement. Overhead losses are losses to the personnel structure minus manpower requirements and manpower losses. (Table 6-1).

Steady-state personnel requirements of the personnel structure are the secondary output parameter of the IMPACT model. This parameter is used as a relative measure of the personnel requirements of one system as compared to those of another system. Replacement for losses primarily occur by promoting from the lower paygrade. Therefore, if manpower requirements begin at an E-4 level, personnel are needed in lower paygrades to be promoted as manpower losses occur. These personnel requirements, over and above manpower requirements, are considered to be overhead supporting a particular weapon system, although potentially they may be used by another weapon system. A measure of the quantity and quality of the personnel structure provides an indication of how efficiently specific manpower requirements sustain themselves. For example; a structure of manpower requirements which decreases as the paygrade spread increases is more self-sustaining than the opposite situation (the more paygrades the manpower requirements are distributed over, the less personnel will be required to support those manpower requirements). The example in Table 6-2 shows the impact on a personnel structure and personnel to be trained for two equal sets of manpower requirements with different grade distributions.

6.3 APPLICATION TO CSWS

6.3.1 Establish Personnel Portion of CDB

Due to the lack of Army historical data on the career history of individual MOS (formal and on the job training), career paths were not examined. The purpose of studying career paths in detail, when feasible, is to differentiate among groups of individuals with different patterns of school and

Table 6-1. IMPACT OUTPUT.

MOS = 15XX   RECRUITS PER YEAR = 905.5

PAYGRADE	PERSONNEL REQUIREMENTS	UNADJUSTED MANPOWER	TTHS ADJUSTED MANPOWER	PERSONNEL TO BE TRAINED PER YR	MANPOWER LOSSES PER YR	OVERHEAD LOSSES PER YR
E-1	496.4	0.	0.	905.5	0.	905.5
E-2	306.9	0.	0.	649.3	0.	649.3
E-3	461.4	360.0	376.6	538.9	439.8	99.0
E-4	664.1	360.0	377.3	417.1	236.9	180.1
E-5	370.8	360.0	370.8	178.0	178.0	0.0
E-6	304.8	180.0	184.9	89.0	54.0	35.0

MOS = 15XX

PAYGRADE	MANPOWER	ATTRITION	UPGRADE	TTHS
E-1	0.	0.516	1.308	0.
E-2	0.	0.360	1.756	0.050
E-3	360.0	0.264	0.904	0.046
E-4	360.0	0.360	0.268	0.048
E-5	360.0	0.240	0.240	0.030
E-6	180.0	0.144	0.148	0.027
E-7	−1.0	0.164	0.148	0.
E-8	−1.0	2.500	0.	0.
E-9	−1.0	0.	0.	0.

Table 6-2. COMPARATIVE PERSONNEL STRUCTURE IMPACTS.

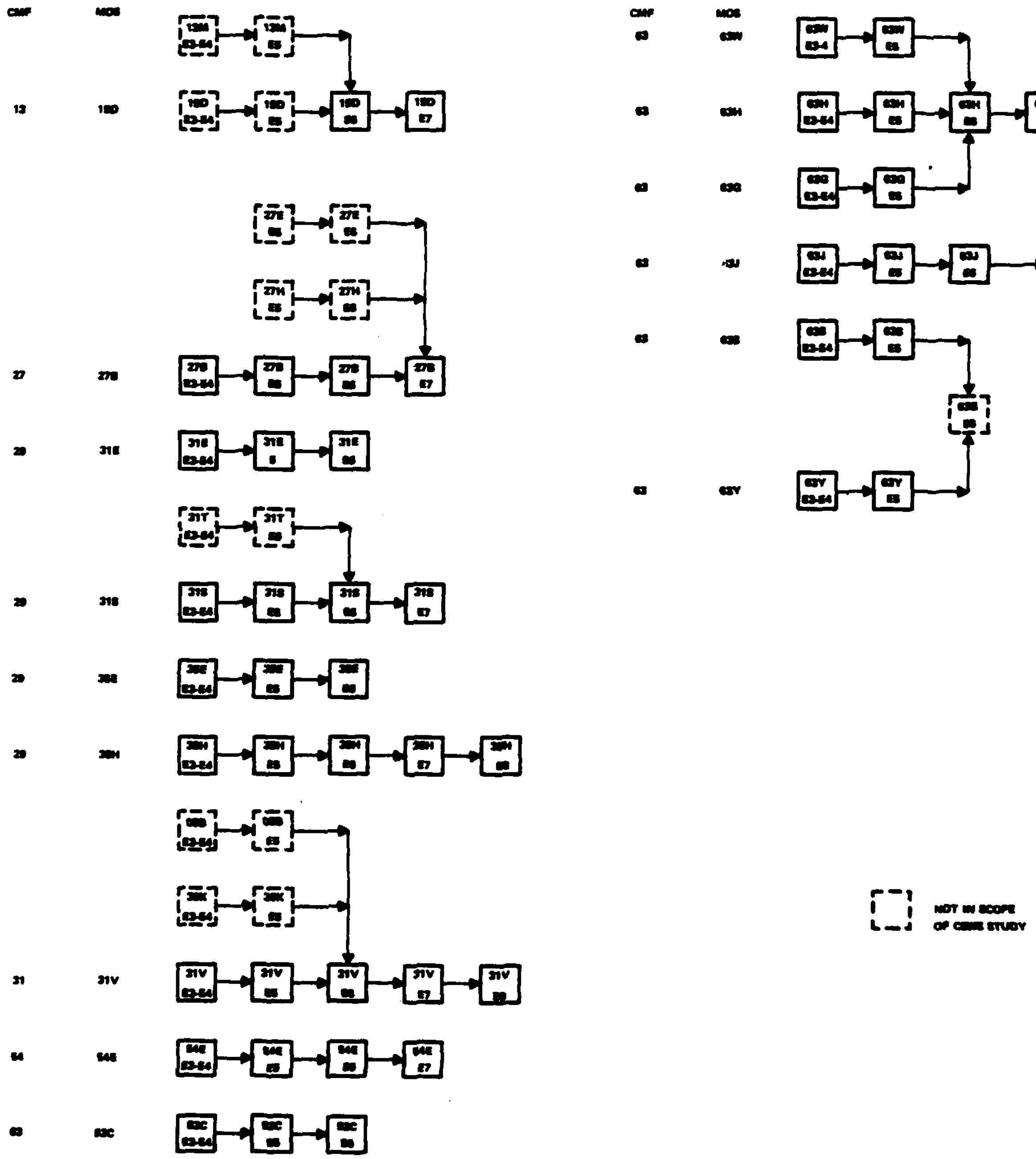
MOS = 15XX RECRUITS PER YEAR = 278.8

PAYGRADE	PERSONNEL REQUIREMENTS	UNADJUSTED MANPOWER	TTHS ADJUSTED MANPOWER	PERSONNEL TO BE TRAINED PER YR	MANPOWER LOSSES PER YR	OVERHEAD LOSSES PER YR
E-1	152.9	0.	0.	278.8	0.	278.8
E-2	94.5	90.0	94.5	200.0	200.0	0.0
E-3	142.1	80.0	83.7	165.9	97.7	68.2
E-4	204.5	70.0	73.4	128.4	46.1	82.4
E-5	114.2	60.0	61.8	54.8	29.7	25.1
E-6	93.9	40.0	41.1	27.4	12.0	15.4
E-7	44.5	20.0	20.0	13.9	6.2	7.7

MOS = 15XX RECRUITS PER YEAR = 452.7

PAYGRADE	PERSONNEL REQUIREMENTS	UNADJUSTED MANPOWER	TTHS ADJUSTED MANPOWER	PERSONNEL TO BE TRAINED PER YR	MANPOWER LOSSES PER YR	OVERHEAD LOSSES PER YR
E-1	246.2	0.	0.	452.7	0.	452.7
E-2	163.4	0.	0.	324.7	0.	324.7
E-3	230.7	0.	0.	269.4	0.	269.4
E-4	332.1	180.0	188.6	208.5	118.5	90.1
E-5	185.4	180.0	185.4	89.0	89.0	0.0

Figure 6.2. CSWS related MOS career progressions



career history, since these different groups generate different personnel flow rates. Figure 6-2 shows the career paths for CSWS MOS.

Due to a change in policy, DRC was unable to receive the actual enlisted Master File (EMF) data in time for the CSWS application. As an alternative, two sources provided data which were generated by extracting elements from the EMF. The Defense Manpower Data Center (DMDC) was able to supply two of the input rates for IMPACT promotion and attrition, as well as inventory information. DRC received in tape form the quarterly promotion and attrition rates for the years 1980 and 1981. The Chief of Personnel Operations (COPO) 45 Report was the source of the third input parameter: Trainees, Transients, Holdees and Students (TTHS). DRC received the TTHS data in microfiche form, by quarters for the years 1980 and 1981 from the U.S. Army Military Personnel Center (MILPERCEN). Quarterly snapshots were taken over a two year period of current personnel status, beginning in December 1979.

6.3.2 Establish Personnel Pipeline Characteristics

DMDC supplied personnel flow characterics (attrition and promotion) by tracking individuals across successive quarters. The data were separated by MOS/paygrade. Promotion and attrition rates were calculated by tracking and counting individuals whose Active/Inactive indicator (code RSCD of EMF) was active. This code indicates if an individual is or is not chargeable to the active strength of the Army. If an individual's status code or MOS classification changed, this change was considered to be attrition to that particular MOS/paygrade. If an individual's paygrade increased, this was considered to be a promotion. Individuals who were part of the active Army but were either Trainees, Transients, Holdees, or Students, were classified as overhead. The COPO 45 Report supplied by MILPERCEN seperated the active code into the operational force and TTHS. Quarterly rates were calculated for every MOS and paygrade. Weighted averages were taken for yearly rates since inventory levels vary across periods of time.

6.3.3 Calculate Personnel Requirements

Results of the IMPACT model for each of the 15 MOS considered in the CSWS application are contained in Appendix D1. Tables 6-3 through 6-5 are summary charts of these results, depicting personnel requirements by MOS, by paygrade and the annual recruit rate, respectively.

TABLE 6-3. PERSONNEL REQUIREMENTS BY MOS.

MOS	Reference Tracked	Reference Wheeled	Baseline I Lance	Baseline MLIS	Baseline Lance II
15XX	2604	2604	2604	2604	2604
ASI	459	430	430	203	344
27B	377	290	348	58	290
31E	344	322	129	111	129
31S	18	18	18	18	18
31V	339	339	141	141	141
35E	485	303	40	40	40
35H	17	17	17	17	17
52C	414	219	487	199	292
54E	25	25	25	25	25
63G	28	79	14	14	28
63H	640	—	349	214	—
64J	179	154	333	179	179
63S	273	227	182	227	454
63W	528	918	551	688	642
63Y	407	—	204	81	—

TABLE 6-4. PERSONNEL REQUIREMENTS BY PAYGRADE

GRADE	Reference		Baseline		
	Tracked	Wheeled	I Lance	MLIS	Lance II
E-1	1668.1	1404.3	1343.8	1178.9	1183.8
E-2	1118.0	893.7	882.5	753.2	765.4
E-3	1613.0	1303.0	1274.2	1082.6	1101.8
E-4	1895.0	1525.4	1596.2	1297.5	1389.1
E-5	535.2	513.6	468.6	422.3	459.2
E-6	304.8	304.8	304.8	304.8	304.8
E-7	—	—	—	—	—
E-8	—	—	—	—	—
E-9	—	—	—	—	—
TOTAL	7134.1	5944.8	5870.1	5039.3	5204.1

TABLE 6-5. RECRUITING REQUIREMENTS.

MOS	Reference		Baseline		
	Track	Wheel	I Lance	MLIS	Lance II
15X	496.4	496.4	496.4	496.4	496.4
ASI	180.1	168.8	168.8	112.6	135.1
27B	63.1	48.5	58.2	57.9	48.5
31E	59.2	55.5	22.3	19.1	22.3
31S	3.8	3.8	3.8	3.8	3.8
31V	129.2	129.2	53.8	53.8	53.8
35E	113.8	71.1	14.2	14.2	14.2
35H	3.6	3.6	3.6	3.6	3.6
52C	92.3	48.8	108.5	43.4	65.1
54E	8.0	8.0	8.0	8.0	8.0
63G	9.9	19.8	5.0	5.0	9.9
63H	166.0	—	90.6	55.4	—
63J	32.3	27.7	60.1	32.3	32.3
63S	59.6	49.7	39.7	49.7	99.4
63W	157.2	273.4	164.0	205.0	191.4
63Y	93.6	—	46.8	18.7	—

SECTION 7 - CONDUCT IMPACT ANALYSIS

7.1 OVERVIEW

In the HARDMAN methodology, Impact Analysis determines the impact that an emerging system's personnel and training demands will place upon the projected supply of personnel and training resources. The supply/demand comparison surfaces the system's "high drivers," i.e., those factors, whether design, personnel or training policy, maintenance plan or scenario, which would consume a disproportionate share of the available resources. It is these high drivers which are the likely focus of tradeoff analyses (step 6 of the HARDMAN methodology) as a result of their having the largest payoff potential.

The application of HARDMAN to CSWS represents the first instance of Impact Analysis conducted on an Army system. The CSWS study benefitted from some preliminary investigations into Impact Analysis conducted in the course of the DSWS effort. The CSWS study confirmed that the key to an effective supply/demand comparison is the accurate projection of the likely supply of personnel and training resources at the time of an emerging systems deployment. Tools and techniques adequate to the task do not presently exist, or if the basic means are present (as in the Personnel Policy Project Model (P^3M) mentioned below), their typically short horizon (1-3 years) is of little value when compared with average system development times (5-7 years). The short horizon coincides with the typical current year/budget year/program year orientation of the PPBS process; whether this constitutes a cause and effect relationship or merely coincidence one can only speculate.

Consequently, the current state of the Impact Analysis conducted for Army applications of HARDMAN can be described as rudimentary. However, this does not mean that meaningful results were not obtained. On the contrary, an effective Impact Analysis was conducted by taking advantage of a major, and not unreasonable, simplifying assumption: that CSWS will represent a complete addition to the Army's force structure (and hence manpower, personnel and training) requirements. In other words, no system presently deployed will be replaced by CSWS. The reasonableness of this assumption stems from the Battlefield Development Plan, which indicates that the Army completely lacks the capability which CSWS represents, thus establishing the CSWS system requirement.

The utility of this major simplifying assumption is elaborated upon in the following sections, which describe training and personnel impacts, respectively.

7.2 TRAINING IMPACTS

For a determination of training impacts, the assumption that CSWS will represent a complete addition implies that existing training resources will be, and will remain, completely committed to training *presently* being conducted. Thus, the CSWS training resource requirements, or demands, determined in Section 5 are completely "unfunded," and consequently the impacts of these demands are the demands themselves. It remains only to rank order each of the three training resource requirements (man-days, instructors, and costs) in descending order. The high drivers are those of the highest rank. The results of this ranking are displayed in Tables 7-1 thru 7-3.

Table 7-1. TRAINING IMPACTS: MAN-DAYS.

RANK	TRACKED REFERENCE		WHEELED REFERENCE		I LANCE		MLIS		LANCE II	
ORDER	MOS	MAN-DAYS	MOS	MAN-DAYS	MOS	MAN-DAYS	MOS	MAN-DAYS	MOS	MAN-DAYS
01	15XX	30,307.	15XX	30,307.	15XX	40,246.	15XX	40,049.	15XX	33,456.
02	27B	23,528.	63W	29,358.	27B	21,798.	63W	11,940.	63W	19,286.
03	63H	21,852.	27B	18.165.	63W	15,120.	27B	10,899.	27B	18,165.
04	35E	21,472.	31E	16,065.	63H	11,721.	63H	6,770.	63S	9,503.
05	31E	17,145.	35E	13,371.	52C	11,457.	31E	5,740.	52C	6,897.
06	63W	14,460.	31V	12,571.	31E	6,720.	31V	5,200.	31E	6,720.
07	31V	12,571,	ASIXX	5,561.	ASIXX	5,561.	63S	4,773.	31V	5,200.
08	52C	9,747.	52C	5,130.	31V	5,200.	52C	4,560.	63J	3,876.
09	63Y	6,798.	63S	4,773.	63J	5,016.	35E	2,733.	ASIXX	3,216.
10	ASIXX	5,928.	63J	2,318.	63S	3,784.	63J	2,698.	35E	2,733.
11	63S	5,719.	63G	2,200.	63Y	3,399.	ASIXX	2,654.	63G	1,100.
12	63J	2,698.	54E	688.	35E	2,733.	63Y	1,353.	54E	688.
13	63G	1,100.	31S	585.	54E	688.	54E	688.	31S	585.
14	54E	688.	35H	80.	31S	585.	31S	585.	35H	80.
15	31S	585.	63H	—	63G	550.	63G	550.	63H	—
16	35H	80.	63Y	—	35H	80.	35H	80.	63Y	—

Table 7-2. TRAINING IMPACTS: INSTRUCTORS.

RANK	TRACKED REFERENCE		WHEELED REFERENCE		I LANCE		MLIS		LANCE II	
ORDER	MOS	INSTRUCTORS	MOS	INSTRUCTORS	MOS	INSTRUCTORS	MOS	INSTRUCTORS	MOS	INSTRUCTORS
01	27B	41.1	27B	32.4	72B	48.2	15XX	31.1	27B	31.8
02	15XX	22.6	15XX	22.6	15XX	31.4	27B	19.1	15XX	25.2
03	31E	18.0	63W	21.4	63W	11.0	63W	8.7	63W	14.0
04	63H	15.5	31E	16.9	63H	8.3	31E	6.2	31E	7.1
05	35E	15.0	31V	11.3	52C	7.5	31V	4.7	63S	6.5
06	31V	11.3	35E	9.5	31E	7.1	63H	4.7	31V	4.9
07	63W	10.4	ASIXX	6.9	ASIXX	6.9	63S	3.3	52C	4.5
08	ASIXX	7.3	52C	3.3	31V	4.6	ASIXX	3.2	ASIXX	3.9
09	63Y	6.7	63S	3.3	63J	4.3	52C	2.9	63J	3.3
10	52C	6.3	63J	2.0	63Y	3.3	63J	2.3	35E	1.9
11	63S	3.9	63G	1.4	63S	2.6	35E	1.9	31S	.9
12	63J	2.3	31S	.9	35E	1.9	63Y	1.4	54E	.8
13	31S	.9	54E	.8	31S	.9	31S	.9	63G	.7
14	54E	.8	35H	.1	54E	.8	54E	.8	35H	.1
15	63G	.7	63H	—	63G	.3	63G	.3	63H	—
16	35H	.1	63Y	—	35H	.1	35H	.1	63Y	—

Table 7-3. TRAINING IMPACTS: COURSE COSTS ($K).

RANK	TRACKED REFERENCE		WHEELED REFERENCE		I LANCE		MLIS		LANCE II	
ORDER	MOS	COST	MOS	COST	MOS	COST	MOS	COST	MOS	COST
01	15XX	5709	63W	5411	15XX	6557	15XX	6530	15XX	5627
02	35E	4297	15XX	5197	27B	3886	63W	2368	63W	3672
03	27B	4137	27B	3351	63W	2978	27B	2225	27B	3351
04	63W	3728	35E	2840	52C	2702	63H	1240	52C	1713
05	63H	3392	31E	2350	63H	1868	52C	1168	31E	1015
06	31E	2498	31V	1911	ASIXX	1064	31E	871	31V	819
07	52C	2342	52C	1303	31E	1015	31V	819	63J	797
08	31V	1911	ASIXX	1054	63J	999	35E	652	63S	796
09	63Y	1175	63G	580	31V	819	63J	575	35E	650
10	ASIXX	1118	63J	500	63Y	595	ASIXX	546	ASIXX	646
11	63J	575	63S	403	63S	320	63S	403	63G	295
12	63S	782	54E	175	35E	312	63Y	239	54E	175
13	63G	295	31S	78	54E	175	54E	175	31S	78
14	54E	115	35H	72	63G	149	63G	149	35H	72
15	31S	78	63H	—	31S	78	31S	78	63H	—
16	35H	72	63H	—	35H	72	35H	72	63Y	—

7.3 PERSONNEL IMPACTS

7.3.1 Process

A comparison of the personnel demands of a new system to available personnel resources can indicate three conditions: (a) a surplus of resources relative to demand, (b) a shortage of resources, or (c) projected resources are adequate to meet demand. In Impact Analysis, the first condition is called a surplus, the second a shortfall, and the third condition is referred to as neutral.

Two types of personnel data, authorizations and availability, were used to make the supply/demand comparison. Authorizations are those manpower positions, or spaces, for which the Army has received (or must request) funding authority from the Congress. Thus authorizations constitute a statement of the Army's demand for manpower. Availability, on the other hand, is a statement of the personnel system's ability to fill the authorized positions with individuals. In any current year, availability is a statement of personnel inventory on-hand. In a future year, it is an estimate of future supply.

It must be noted that authorizations do not reflect the force structure required to satisfy the various missions with which the Army has been tasked. In peacetime, the Army chooses not to man (i.e., authorize) 100 percent of its units at 100 percent of their force structure requirement, in order to divert resources to higher priority objectives. Consequently, authorizations always are lower than requirements; stated another way, the manpower demand reflected by requirements is always higher than that reflected by authorizations. It is not possible to make an analysis of how an emerging system's manpower requirements impact on the total force structure requirements without knowing how the force structure requirement is allocated to the various systems and MOS. This information was not available for the CSWS study.

It was, however, possible to determine impact of CSWS for a supply/demand comparison based on authorizations. CSWS will represent a complete increase to present projections of both authorizations and availability, since it is also assumed that no systems will be replaced by CSWS.[1] Thus, 100 percent of the CSWS manpower (i.e., force structure) requirement will be added to present authorization. An availability ratio (AR) may now be calculated.

$$AR = \frac{\text{Availability}}{\text{Authorizations} + \text{CSWS Manpower}}$$

$$AR < 1 = \text{Shortfall}$$
$$AR > 1 = \text{Surplus}$$
$$AR = 1 = \text{Neutral}$$

Availability and Authorization data, by MOS and paygrade, for fiscal year (FY) 1983 were provided from the Army's Personnel Policy Project Model (P³M). While subject to the short horizon problem mentioned earlier, the data were accepted as the "best estimate" on which to base near-term decisions regarding CSWS. Further, the data were inflated to allow for the effect of the TTHS account. These figures had to be backed out using the TTHS percentages from the COPO 45 report used in Section 6. Thus the final equation was:

$$AR = \frac{[\text{Availability}] \times [1 - \%\ \text{TTHS}]}{([\text{Authorizartions}] \times [1 - \%\ \text{TTHS}]) + \text{CSWS Manpower}}$$

[1] The two new skills required by CSWS, 15XX and ASIXX, CSWS Crewmember and Mechanic, respectively, were assumed to impact upon the existing LANCE MOS, 15D. Their true availability ratios are zero, since these skills do not presently exist in the inventory. However, the impacts presented here represent the more realistic case, where CSWS will draw its manpower from the existing 15D pool.

Adjusted availability and authorizations for the 15 MOS considered by the CSWS study are displayed as Tables 7-4. CSWS manpower requirements are displayed as Table 7-5. Table 7-6 displays the Availability Ratio results. The following section describes the P^3M model and how availability and authorization were defined.

7.3.2 The Personnel Policy Project Model (P^3M).

The Personnel Policy Project Model (P^3M) projects actual inventory or availability (supply) by MOS/paygrade. Inputs to P^3M include a continuation rate which contains (a) reenlistment rates; (b) retirement rates (career or medical retirement); (c) miscellaneous rates (death, desertion, discharge); (d) attrition; (e) promotion and a feeder rate. DRC received 1983 availability rates which are a function of projected personnel policies for 1983. The above rates are sensitive to 1983 increases or decreases in Army internal variables, such as bonus levels. By changing bonus levels for MOS/paygrades, changes will occur in the continuation rates. For example, if a bonus is taken away, reenlistments rates will drop for that particular MOS/ paygrade and if bonuses are increased, reenlistment rates will increase which is a linear function. The objective of P3M is to index retention rates based on years of service. These rates are divided into three time zones within each paygrade; (1) first term personnel (1-6 years); (2) midservice personnel (6-10 years); and (3) career personnel (1O years and up). Rates would vary among first termers, mid-service, and career personnel. For example, career personnel would have higher retirement rates than first termers or mid-service personnel and first term personnel would have higher attrition and promotion rates than career personnel.

Authorizations are the quantity and type of people funded to fill manpower requirements (demand). The baseline for authorizations originates from the Personnel Structure and Composition System (PERSACS) which is a detailed summary of authorizations (requests) submitted by field organizations. The baseline is then adjusted according to the following internal changes projected to occur; (a) new equipment densities; (b) structure changes; (c) deployment schedules, and (d) the Quantitative and Qualitative Personnel Requirements Information (QQPRI) used to calculate total force system specific manpower requirements. All these changes are taken into consideration for new systems. Between the field requests and internal changes, the quantities of personnel to be funded through authorizations are projected.

TABLE 7-4. ADJUSTED AVAILABILITY/AUTHORIZATIONS FY 1983.

TOTAL MOS/PAYGRADE

MOS	AVAILABILITY	AUTHORIZATIONS
15XX	2788.85	2509.96
27B	432.14	436.06
31E	1631.02	1624.33
31S	607.98	604.98
31V	6628.23	6216.30
36E	616.90	504.82
36H	971.83	1533.18
52C	1644.69	1533.18
54E	5736.79	6106.40
63G	795.15	754.22
63H	6085.21	5894.28
63J	1128.65	876.39
63S	1271.83	1236.80
63W	2633.94	2425.32
63Y	1675.27	1359.25

TABLE 7-5. CSWS MANPOWER REQUIREMENTS

MOS	Reference		Baseline		
	Track	Wheel	I Lance	MLIS	Lance II
15XX	1420	1230	1410	1180	1200
27B	125	95	115	55	100
31E	165	135	65	55	65
31S	5	5	5	5	5
31V	120	120	50	50	50
35E	140	95	15	15	15
35H	5	5	5	5	5
52C	100	60	115	55	75
54E	10	10	10	10	10
63G	10	25	5	5	10
63H	190	—	105	65	—
63J	45	35	75	45	40
63S	80	70	60	70	140
63W	150	250	155	170	180
63Y	140	—	60	30	—

Table 7-6. AVAILABILITY RATIO RESULTS.

	CURRENT FY 83 PROJECTION	REFERENCE TRACKED		REFERENCE WHEELED		BASELINE I LANCE		BASELINE MLIS		BASELINE LANCE II	
15XX	1.11	(.36)	0.71	(.32)	0.75	(.36)	0.71	(.32)	0.76	(.32)	0.75
27B	0.99	(.22)	0.77	(.18)	0.81	(.21)	0.78	(.11)	0.88	(.18)	0.81
31E	1.00	(.09)	0.91	(.07)	0.93	(.03)	0.97	(.03)	0.97	(.03)	0.97
31S	1.01	(.01)	1.00	(.01)	1.00	(.01)	1.00	(.01)	1.00	(.01)	1.00
31V	1.07	(.02)	1.05	(.02)	1.05	(.01)	1.06	(.01)	1.06	(.01)	1.06
36E	1.22	(.21)	0.96	(.16)	1.03	(.03)	1.19	(.02)	1.19	(.03)	1.19
85H	1.16	(.00)	1.16	(.00)	1.16	(.00)	1.16	(.00)	1.16	(.00)	1.16
52C	1.07	(.06)	1.01	(.04)	1.03	(.07)	1.00	(.03)	1.04	(.05)	1.02
54E	0.94	(.00)	0.94	(.00)	0.94	(.00)	0.94	(.00)	0.94)	(.00)	0.94
63G	1.05	(.01)	1.04	(.03)	1.02	(.00)	1.05	(.00)	1.05	(.01)	1.04
63H	1.03	(.03)	1.00	).00)	1.03	(.02)	1.01	(.01)	1.02	(.00)	1.03
63J	1.29	(.05)	1.23	(.04)	1.24	(.08)	1.19	(.05)	1.22	(.05)	1.23
63S	1.03	(.06)	0.97	(.06)	0.97	(.05)	0.98	(.06)	0.97	(.11)	0.92
63W	1.09	(.06)	1.02	(.10)	0.98	(.06)	1.02	(.07)	1.01	(.07)	1.01
63Y	1.23	(.09)	1.12	(.00)	1.23	(.04)	1.18	(.02)	1.20	(.00)	1.23

*Impact of system availability percentage decreases compared to current FY83 projections shown in parentheses.

SECTION 8 - RESULTS

This section contains a discussion of the results derived from the application of the HARDMAN methodology to the Corps Support Weapon System (CSWS). Section 8.1 deals with the specific findings of the analysis. Section 8.2 contains the conclusions reached as to the meaning of the findings and/or their relevance to the objectives of the study. Recommendations for futher action are contained in Section 8.3.

8.1 FINDINGS

A summary of results is depicted in Table 8-1. For the most part, these are self-explanatory and are discussed in more detail in the preceeding sections, and in some cases, in still more detail in the Appendices. The exception is the Standby Time percentage, under the mission category. This result is explained in the following paragraphs.

As discussed in Section 4, manpower requirements are developed from two basic workload categories: operational and maintenance. In other applications of the HARDMAN methodology, it has been found that seemingly small variations in manpower requirements mask significant differences across alternative system concepts in the time spent actively engaged in required work. This situation is due to the indivisibility of the required asset—a person. A system that needs only part of an individual's productive capacity must take all of that person, not just the portion it requires.

Thus, the small difference (7 vs 6) in crew manpower requirements for the ILANCE versus both MLIS and LANCE II hides a large variation in the workload required of each system to complete a specified mission set. These workloads are displayed in Table 8-2 (Communications workload is not included since the capability is always required. However, resupply time is included for the SPL since in this case, it is the system, rather than the crew, which is actively engaged). Standby time is the difference between the time required to perform a specified mission set and the time available, in this case 168 hours. Thus, standby time represents the ability of a system to take on additional work. Standby time is also displayed in Table 8-2. The Standby Time percentage in the summary chart is merely the standby time divided by the available time, expressed as percentage, with a higher percentage being the more desirable condition. The Standby Time percentage may be thought of as a system effectiveness measure in lieu of Operational Availablity (A_O). A_O cannot be expressed since no logistic delay times were available.

8.2 CONCLUSIONS

8.2.1 CSWS Alternatives

The boxed figures on Table 8-1 highlight the most favorable result in each category. The Multiple Launch Interdiction System (MLIS) alternative emerges as the preferred candidate for CSWS. This result is due to a combination of several factors: the integrated design concept upon which MLIS is based, lower response and resupply times due to the multiple launch capability, and lower overall operational times which in turn decrease the demand for maintenance. It should be kept in mind that the scenario usage data upon which the subsequent MPT analyses depend are not completely authoritative. The CSWS Mission Profile/Operational Mode Summary was not available to DRC during the course of this study. Therefore, the advantage that MLIS displays over the next closest alternative, LANCE II, may be reduced or eliminated completely under different employment

TABLE 8-1. CSWS RESULTS SUMMARY
(180 SPL, 180 RSV)

Category	Reference Systems: Tracked	Reference Systems: Wheeled	Baseline Systems: I Lance	Baseline Systems: MLIS	Baseline Systems: Lance II
MISSION					
STANDBY TIME %					
SPL	17.6	52.6	15.5	$\boxed{57.7}$	49.8
RSV	42.4	69.0	40.6	$\boxed{69.1}$	55.2
MANPOWER					
CREW	1260	1080	1260	$\boxed{1080}$	$\boxed{1080}$
ORGANIZATIONAL MAINTENANCE	570	380	390	$\boxed{290}$	360
DS MAINTENANCE	825	635	590	$\boxed{380}$	465
PERSONNEL					
NUMBER OF MOS	16	14	16	16	$\boxed{14}$
PERSONNEL REQUIREMENTS	7137	5945	5872	$\boxed{5040}$	5203
ANNUAL RECRUIT RATE	1668.1	1404.3	1343.8	$\boxed{1178.9}$	1183.8
TRAINING					
ANNUAL TRAINING MAN-DAYS (K)	174.7	141.2	134.7	$\boxed{101.3}$	111.5
ANNUAL INSTRUCTOR REQUIREMENTS	162.6	132.7	128.9	$\boxed{91.6}$	105.6
ANNUAL COURSE COSTS ($M)	$31.980	$25.225	$23.580	$\boxed{\$18.108}$	$19.709

TABLE 8-2. WORKLOAD VARIATIONS.

(168 hour week, 161 missiles fired)

Vehicle	Workload	Reference		Baseline		
		Tracked	Wheeled	I Lance	MLIS	Lance II
SPL	MOBILITY	30.17	16.77	30.17	26.2	22.14
	FIRE MISSION	7.01	7.01	9.39	4.29	6.69
	RESUPPLY	59.03	16.34	52.99	12.75	35.48
	MAINTENANCE	41.99	39.49	49.49	27.75	20.05
	TOTAL	138.47	79.61	142.04	70.99	84.36
STANDBY TIME		29.53	88.39	25.96	97.01	83.64
RSV	MOBILITY	20.27	20.27	20.27	20.27	20.27
	RESUPPLY	59.03	16.34	52.99	12.75	35.48
	MAINTENANCE	14.78	14.44	24.04	18.94	19.57
	TOTAL	94.08	51.05	97.3	51.96	75.32
STANDBY TIME		73.92	116.95	70.7	116.04	92.68

assumptions. Another factor which contributes to the MLIS advantage is the presence of a multiple round resupply capability, versus single round resupply on the other alternatives. Although LANCE II uses a canistered round, each canister must be loaded separately, compared with multiple round loading on MLIS. This factor reduces resupply and associated operating times drastically and contributes significantly to the preference for MLIS.

8.2.2 The HARDMAN Methodology

The identification of appropriate data sources, and the subsequent collection of required data, continue to be the largest factors driving both the time and funds required for a HARDMAN application. Numerous problems in this regard were encountered in the CSWS application. Some data sources (persons/agencies) were either unwilling to provide requested data, or would do so only after extensive clearances were obtained. This situation imposed additional administrative burdens upon project personnel, as well as the COTR, and hence decreased the time available for analysis.

This situation is further confirmation of the finding in the previous application of HARDMAN in the Army, (a study of the Division Support Weapon System), i.e., that data are usually available but they are fragmented and not effectively organized to support front-end analysis. While not precluding effective analysis, in both this and other applications, this fragmentation makes both the cost and time required higher than they should be for a single HARDMAN application. The questions of data, and access to data, are ones that must be addressed as initial considerations in any future HARDMAN application and in the conduct of front-end analysis generally in the Army.

8.3 RECOMMENDATIONS

The one central recommendation of this report is that tradeoff analyses be continued to confirm and verify the the results of the report. At a minimum, these tradeoffs should include an alternative approach or change in the scenario information to reflect updated authoritative assumptions, and, also the investigation of a multiple round resupply capability for the LANCE II. It is the above two factors which account for the significant differences in the manpower, personnel and training resource requirements of the two leading candidates for the CSWS development.

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GLOSSARY OF ACRONYMS

AHRS	Attitude Heading Reference System
AMSAA	U.S. Army Material Systems Analysis Activity
APG	Aberdeen Proving Ground, Maryland
AR	Army Regulation
ARI	U.S. Army Research Institute for the Behavioral and Social Sciences
ASARC	Army Systems Acquisition Review Council
ASROC	Anti-Submarine Rocket
BITE	Built-in Test Equipment
BOIP	Basis of Issue Plan
CDB	Consolidated Data Base
CM	Corrective Maintenance (unscheduled)
COPO	Chief of Personnel Operations
CPU	Central Processor Unit
CSWS	Corps Support Weapon System
DCU	Data Conversion Unit
DDA	Detroit Diesel Allison
DMDC	Defense Manpower Data Center
DPC	Data Processor Computer
DS	Direct Support
DSARC	Defense Systems Acquisition Review Council
DT/OT	Developmental Test/Operational Test
EMF	Enlisted Master File
FCP	Fire Control Panel
FCS	Fire Control System
GAWR	Gross Axle Weight Rating
GVWR	Gross Vehicle Weight Rating
HARDMAN	Hardware Acquisition/Manpower Integration
HCPE	Hybrid Collective Protection Equipment
HEMAT	Heavy Expanded Mobility Ammunition Trailer (M989)
HWS	HARPOON Weapon System
IMPACT	Interactive Manpower-Personnel Assessment and Correlation Technology
INS	Inertial Navigation Set
IOC	Initial Operational Capability
LDS	Launcher Drive System
LRA	Launcher Relay Assembly
LSA	Logistics Support Analysis
LSAR	Logistics Support Analysis Record
MA	Maintenance Action
MAA	Mission Area Analysis
MACRIT	Army Manpower Authorization Criteria Process
MAN	Maschinefabrik Augsburg Nurnberg
MET	Meterological Data

MILPERCEN	U.S. Army Military Personnel Center
MLIS	Multiple Launch Interdiction System
MLRS	Multiple Launch Rocket System
MMH	Maintenance Man-Hour
MOS	Military Occupational Specialty
MPT	Manpower, Personnel, Training
MR	Maintenance Ratio
MRA	Manpower Requirements Analysis
NCOES	Non-Commissioned Officer Education System
NETP	New Equipment Training Plan
NTDS	Navy Tactical Data System
OICTP	Outline Individual and Collective Training Plan
PADS	Position Azimuth Determination System
PERSACS	Personnel Structure and Composition System
PM	Preventive Maintenance (Scheduled)
POI	Program of Instruction
PPBS	Planning, Programming & Budgeting System
PRA	Personnel Requirements Analysis
P^3M	Personnel Policy Project Model
QQPRI	Quantitative & Qualitative Personnel Requirements Information
RAM	Reliability, Availability, Maintainability
RPM	Revolutions Per Minute
RSV	Resupply Vehicle
R/T	Radio/Transmitter
SDC	Sample Data Collection
SM	Soldiers Manual
SPL	Self-Propelled Launcher
SPLL	Self-Propelled Launcher Loader
STE/ICE	Simplified Test Equipment for Internal Combustion Engines
STF	Special Task Force
TACOM	U.S. Army Tank-Automotive Command
TECOM	U.S. Army Test and Evaluation Command
TRRA	Training Resource Requirements Analysis
TSS	Test Set Simulator
TTHS	Trainees, Transients, Holdees or Students
WCIP	Weapon Control Indicator Panel
WSAP	Weapon System Acquisition Process